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Survey of Tributaries to the Madison River from Hebgen Dam to Ennis, Montana with an Emphasis on Distribution and Status of Westslope Cutthroat Trout

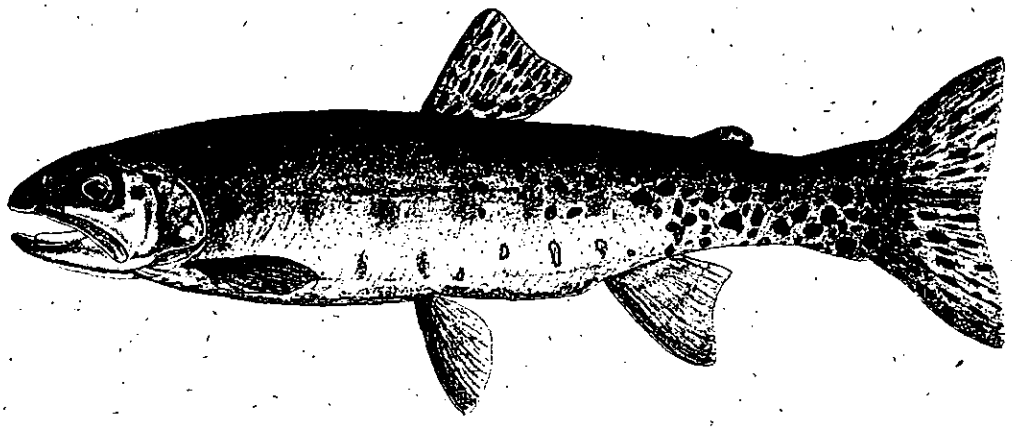

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Table of Contents

List of Tables

List of Figures

Introduction

Prior to about 1900 the Madison River supported populations of native westslope cutthroat trout *Oncorhynchus clarki lewisi*, arctic grayling *Thymallus arcticus*, mountain whitefish *Prosopium williamsoni*, and mottled sculpins *Cottus bairdi* (Jordan 1891; USDI 1954). Steelhead trout *Oncorhynchus mykiss* were stocked into the Madison River in 1900, and brown trout *Salmo trutta* were planted about 1910 (USDI 1954). By 1920 the grayling population had nearly disappeared, but the mountain whitefish populations persisted (USDI 1954). Rainbow trout *Oncorhynchus mykiss* and brook trout *Salvelinus fontinalis* were both introduced around 1920 (USDI 1954). By 1930, both rainbow and brown trout were well established in the Madison River. Releases of hatchery-raised catchable rainbow trout into the Madison River continued until the early 1970's when a research project found that releases of hatchery rainbow trout suppressed populations of wild rainbow and brown trout (Vincent 1987). Releases of hatchery fish into the Madison River ceased in 1974 (Montana Department of Fish, Wildlife and Parks, fish planting database). From 1974 to 1990 the Madison River supported a very popular and successful fishery for wild rainbow and brown trout (Vincent 1980). The rainbow trout population began declining in the early 1990's and in 1994 whirling disease was identified as the cause. Angler catch rates for rainbow trout have declined significantly, while catch rates for brown trout have remained essentially unchanged.

From 1950 to the present, biologists have been documenting a decline in the distribution and abundance of westslope cutthroat trout throughout their range (Hanzel 1959; Rieman and Apperson 1989; Rieman and McIntyre 1993). This decline has been extremely pronounced in the upper Missouri River basin (Shepard et al. 1997). The Madison River drainage now supports only a few isolated populations of westslope cutthroat trout (Shepard et al. 1997). These few remaining cutthroat populations are restricted to headwater portions of tributaries, usually above some type of fish barrier. Recent data from the Madison River suggests that whirling disease has not impacted these cutthroat trout populations and that some cutthroat drift down out of these tributaries to the Madison River. This information suggests that by restoring strong populations of westslope cutthroat trout to tributaries of the Madison River, it may be possible to develop a fishable population of westslope cutthroat trout in the Madison River.

Goals

1. Protect or establish genetically pure populations of westslope cutthroat trout in headwater areas of tributaries of the upper Madison River, by 2006.
2. Develop a fluvial population of westslope cutthroat trout within the Madison River.

This report summarizes data collected by Montana Department of Fish, Wildlife and Parks (Montana FWP) and Montana Cooperative Fishery Research Unit personnel from 1997 to 1999. In addition, data collected from 1994 to 1995 in Cabin and Soap creeks under a contract to the USDA, Forest Service's Rocky Mountain Research Station, Boise, Idaho are also summarized.

Study Area Description

The Madison River is formed at the junction of the Firehole and Gibbon Rivers in Yellowstone National Park. From its headwaters it flows into Montana at Hebgen Reservoir. Below Hebgen Reservoir the river flows into Quake Lake, created in 1959 by an earthquake. After leaving Quake Lake the Madison River flows in a westerly direction for about six miles and then in a northerly direction through the broad Upper Madison Valley for about 45 miles. It has a channel gradient of about 0.5% as it flows through this valley (USDI 1954). After leaving Ennis Lake the river flows about 11 miles through Bear Trap Canyon and then flows 20 miles through another broad valley before its junction with the Jefferson and Gallatin rivers near Three Forks, Montana. Our study area extended along the Upper Madison Valley from the outlet of Hebgen Reservoir dam downstream to about the town of Ennis, Montana (Figure 1). The Gravelly Mountain Range lies to the west, and the Madison Mountain Range lies to the east of the Upper Madison Valley.

The U.S. EPA's Eastern Gravelley Mountain ecoregion forms the western border of the study area (Woods et al. 1999). This ecoregion is underlain with a core consisting of folded and faulted carbonate-rich sedimentary rocks (Mesozoic and Paleozoic) with lower slopes underlain by Precambrian pre-Belt metamorphic and metasedimentary rocks and Tertiary rhyolite. The terrain is subdued, studded with potholes, and mostly forested. The lower slopes of the Gravelley and Madison ranges and floor of the Upper Madison Valley lie within the Dry Intermontane Sagebrush Basins ecoregion. This ecoregion is composed of alluvium, fan, and valley fill deposits with natural vegetation of sagebrush steppe (Woods et al. 1999). The portion of the drainage to the east of the valley immediately below Quake Lake lies within the Gneissic-Schistose Forested Mountains ecoregion. This rugged, glaciated ecoregion is covered with forest that is interspersed with rock outcrops of underlying Precambrian pre-Belt gneiss and schists. The Madison Range is within the Absaroka-Gallatin-Madison-Bridge Sedimentary Mountain ecoregion, a carbonate-rich, mostly forested, partially glaciated region that is slightly less rugged than the Gneissic-Schistose Forested Mountain ecoregion. Faulted and folded Mesozoic and Paleozoic sedimentary rocks, including limestone, underlay this ecoregion.

The U.S. Geological Survey flow station below Hebgen Lake (station number 06038500) has operated since 1909. Flows recorded at this site were above average in all water years (October through September) from 1995 to 1997 and near average in 1998 (Figure 2).

Streams that were surveyed during this study included Arasta, Buffalo, Wigwam, Ruby, Hyde, English George, Nickerson, Quaking Aspen, Wall, Alpine, Tepee, Horse, Soap, Standard creeks and Morgan and Cherry gulches that drain the Gravelley Mountains; Lake Creek that drains the Wade Lake Bench; and Bad Luck, Bear, Burger, Cabin, Cameron, Circle, Corral, Mill, Cougar, Gorge, Indian, McAtee, Moose, No Man, Raw Liver, Shedhorn, Shell, Squaw, Stock, Tolman, Papoose, and Wolf creeks that drain the Madison Range (Appendices A and B). More detailed descriptions of individual streams are provided in the "Results" section below.

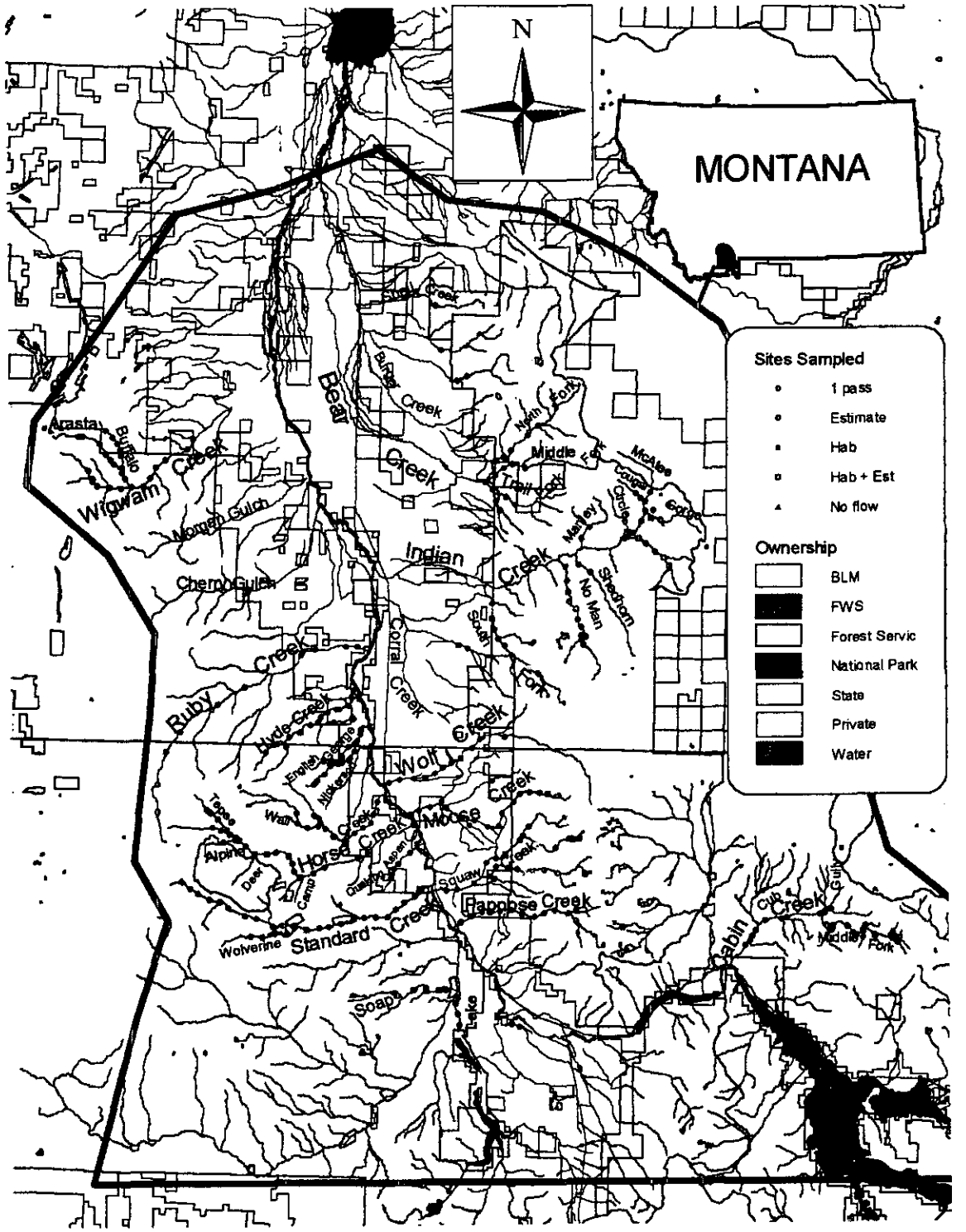

Figure 1. Map of Madison River drainage from Hebgen Lake to Ennis, Montana showing land ownership, names of major streams sampled, and sample sites by type (1 pass = single electrofishing pass with no habitat data; Estimate = fish population estimate with no habitat data; Hab + No Estimate = fish habitat data with no fish population estimate [usually no, or very few, fish captured]; Hab + Est = both fish population estimate and habitat data; or No flow = no stream flow at site).

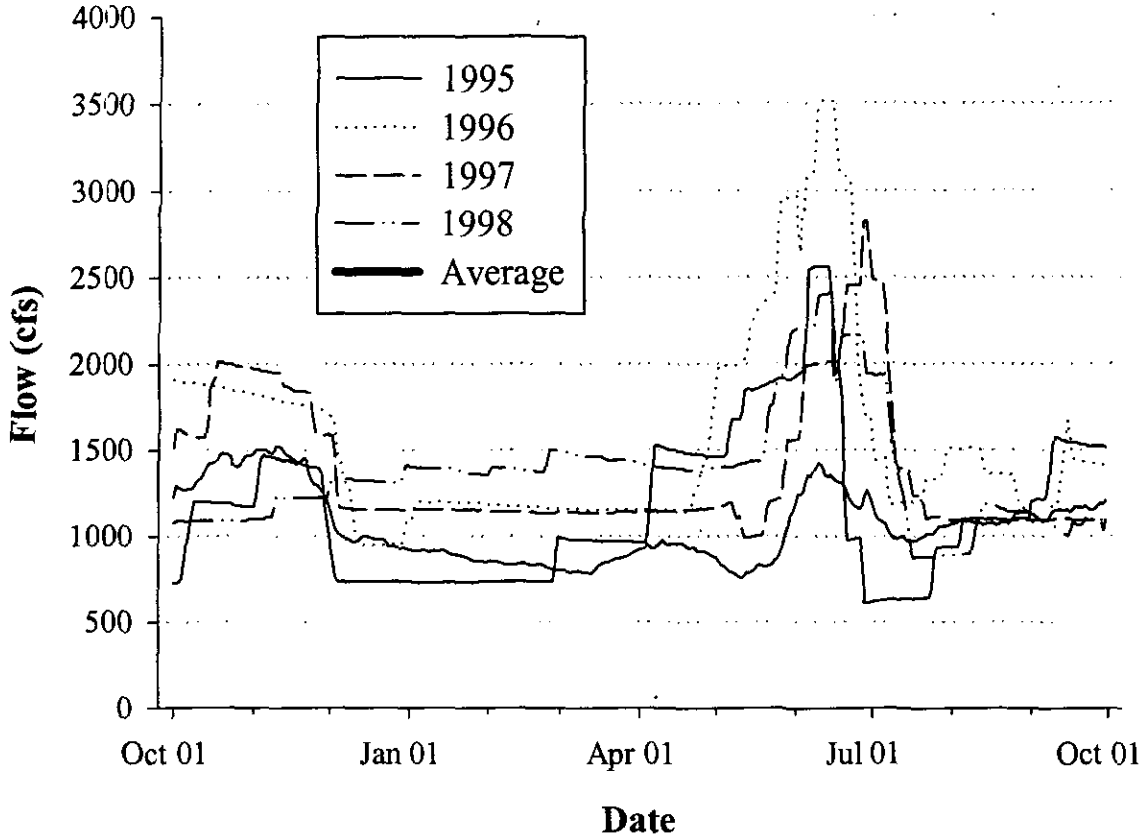

Figure 2. Daily flows in the Madison River below Hebgen Lake for water years 1995 to 1998 along with average daily flows for 61-year period of record (USGS station number 06038500).

Methods

A systematic sampling scheme was employed to estimate both the relative abundance and distribution of fishes and to quantify stream habitat characteristics. Sample sections ranging from 33 to over 1,000 feet were surveyed at a frequency of every 0.5 mile of stream length by single-pass electrofishing with backpack Smith-Root electrofishers (Models SR-12BP, SR-15B). At 2.0 mile intervals we conducted two-, three-, or four-pass depletion population estimates (Van Deventer and Platts 1985). This protocol was modified slightly in some streams where more frequent sampling was done to document the upper and lower extent of the distribution of each fish species. In addition, estimates or habitat surveys were usually not conducted when few or no fish were captured during the first electrofishing pass. Because of time constraints, this protocol was modified in Squaw Creek where the stream was sampled at 1.0 mile intervals, except where more sampling was done to document the upper and lower extent of the distribution of each fish species.

Sample section lengths were at least 30 times the average wetted stream width. Lyons (1992) found that when stream lengths of 35 times the mean wetted width were sampled with a towed

electrofishing unit, all species of fish in fish communities in warmwater streams of Wisconsin were generally captured. Sample sites were referenced by mile above the stream's mouth and by latitude and longitude obtained from a global positions system (GPS). Field GPS locations were input into an ARCVIEW (Version 3.2; 1999; Environmental Systems Research Institute, Inc.) event theme and projected on 1:100,000 stream hydrography layers. The field GPS locations were corrected to overlay the hydrography layer and stream mile locations when discrepancies existed between field GPS and mapped locations.

Length (total length) and weight were recorded for all captured salmonids. For two-pass estimates to provide reasonable results, we assumed that field calculated probabilities of capture (calculated as 1- (C_2/C_1); where C_1= number captured on the first pass, and C_2 = number captured on second pass) had to be 0.80 or higher (see Riley and Fausch 1992). If field calculated probabilities of capture were less than 0.80 after two passes, additional electrofishing passes were usually made. Population estimates were calculated using a maximum likelihood estimator within the MICROFISH program (Van Deventer and Platts 1985) by species for fish 3 inches and longer. Populations estimates of fish 3 inches and longer were also standardized per 1,000 feet of stream length. Relative fish abundance was calculated as the number of fish 3 inches or longer per 1000 feet of stream length captured in the first electrofishing pass.

Either whole fish or fin samples from westslope cutthroat trout were taken for genetic analysis. Where possible, a sub-sample of westslope cutthroat trout captured at each sample site within a stream was represented in the genetic samples. Genetic characteristics were determined by horizontal starch gel electrophoresis (whole fish) or by Paired Interspersed Nuclear DNA Element-PCR (PINE; fin clips) by the University of Montana Wild Salmon and Trout genetics laboratory.

Both reach and site level habitat surveys were conducted. Reach surveys were conducted for the majority of study streams (Appendix A). Reach level habitat surveys counted all habitat types using descriptions from Overton et al. (1997) for reaches with fish present. In addition, all potential barriers to fish movement and dewatered or intermittent segments of streams channels were referenced by latitude and longitude using a GPS unit.

Site level habitat surveys were collected at 2.0 mile intervals in sample sections where fish population estimates were made (Appendix B). The following information was collected for each macrohabitat type within a sample section (Appendix C): length of the macrohabitat type; wetted and channel width (width of normal bank-full channel), measured at a single location which represented an average width and depth of a habitat type; average depth, estimated by taking three depth measurements at equal distances across the single cross section where width was measured and dividing by 4; maximum pool depth; average maximum pool depth using 4 maximum - thalweg - depths were measured longitudinally down the channel and averaged; residual pool depth and volume were estimated using the average maximum depth of the pool minus the maximum depth of the adjacent downstream habitat unit, along with surface area of the pool for volume (Lisle 1987). Over the entire sample section the following information was collected: surface area of suitable spawning habitat (defined as patches of substrate dominated by material 0.4 to 1.2 inches which cover at least 2 ft^2); number of large (>6 inches in diameter) and

small (≤ 6 inches in diameter) woody debris within the stream channel; number of large (>6 inches in diameter) and small (≤ 6 inches in diameter) woody debris which span the stream channel; qualitative assessment of stream bank condition that ranked relative stability from low to high (and described the composition of the streambank and the source of instability); qualitative assessment of instream cover which ranked the relative amount of instream cover from a low to high proportion of water volume with cover; qualitative assessment of bank overhead cover which ranked the amount of the water's surface which is covered or shaded; estimate of surficial streambed composition by size class in percentage by class; qualitative assessment of relative use of riparian areas by livestock or wildlife (Appendix C).

Continuously recording digital thermographs (models WTA08, and HTI, Onset Computer Corporation, Pocasset, Massachusetts) were used to record water temperatures at 76 sites across the Madison River basin (Figure 3). Model WTA08 thermographs were set to record temperatures every 1 hour; because of memory limitations model HTI thermographs were set to record temperatures every 2 hours. Thermographs measured temperatures ranging from 23° F to 98° F with an accuracy of +/- 0.4°F and +/- 0.14 min/d. During early July thermographs were placed in well-mixed pools, shielded from direct solar radiation and left to record stream temperatures until late September. Daily stream temperatures were summarized into daily average, maximum, and minimum recorded temperatures and graphed for each thermograph site by year.

Results

Bear Creek

The Trail, Middle, and North forks of Bear Creek converge a short distance below the Beaverhead-Deerlodge National Forest boundary to form Bear Creek. The Trail Fork of Bear Creek is a small stream originating on the steep, talus slopes of Sphinx Mountain. Conifers dominate the riparian community in the Trail Fork's upper reaches, with willow, cottonwood and aspen dominating the riparian community in its lower reaches. A headgate for a small irrigation ditch creates a barrier to upstream fish migration in the Trail Fork at stream mile 0.25 (Figure 4). The Middle Fork of Bear Creek is a 5.0 mile-long stream. The upper 4.5 miles of stream channel flow through coniferous forest within the Lee Metcalf Wilderness Area, the lower half-mile flows through privately owned land. This lower reach of stream is heavily diverted for irrigation, and is impacted by livestock. On Forest Service land, several large debris jams are present in the Middle Fork of Bear Creek, which may present temporary barriers to upstream fish movement (Figure 4). An unnamed stream enters the Middle Fork at stream mile 1.8, but this stream appears to be too small to support a resident fish population. The North Fork of Bear Creek is a 6.0 mile-long stream flowing through open meadows interspersed with conifer stands in its upper reaches, before entering a narrow canyon section. Within this 2 mile-long canyon, several waterfalls prohibit upstream fish movement (Figure 4). The lowest of these barriers is an 8 foot-high falls at stream mile 1.75. Four additional waterfalls are located between stream miles 2.0 and 3.5. The lower mile of stream flows through privately owned land, which receives heavy use by livestock. Cameron Creek, the North Fork's only tributary below the barrier waterfall, is too small to support a resident fish population.

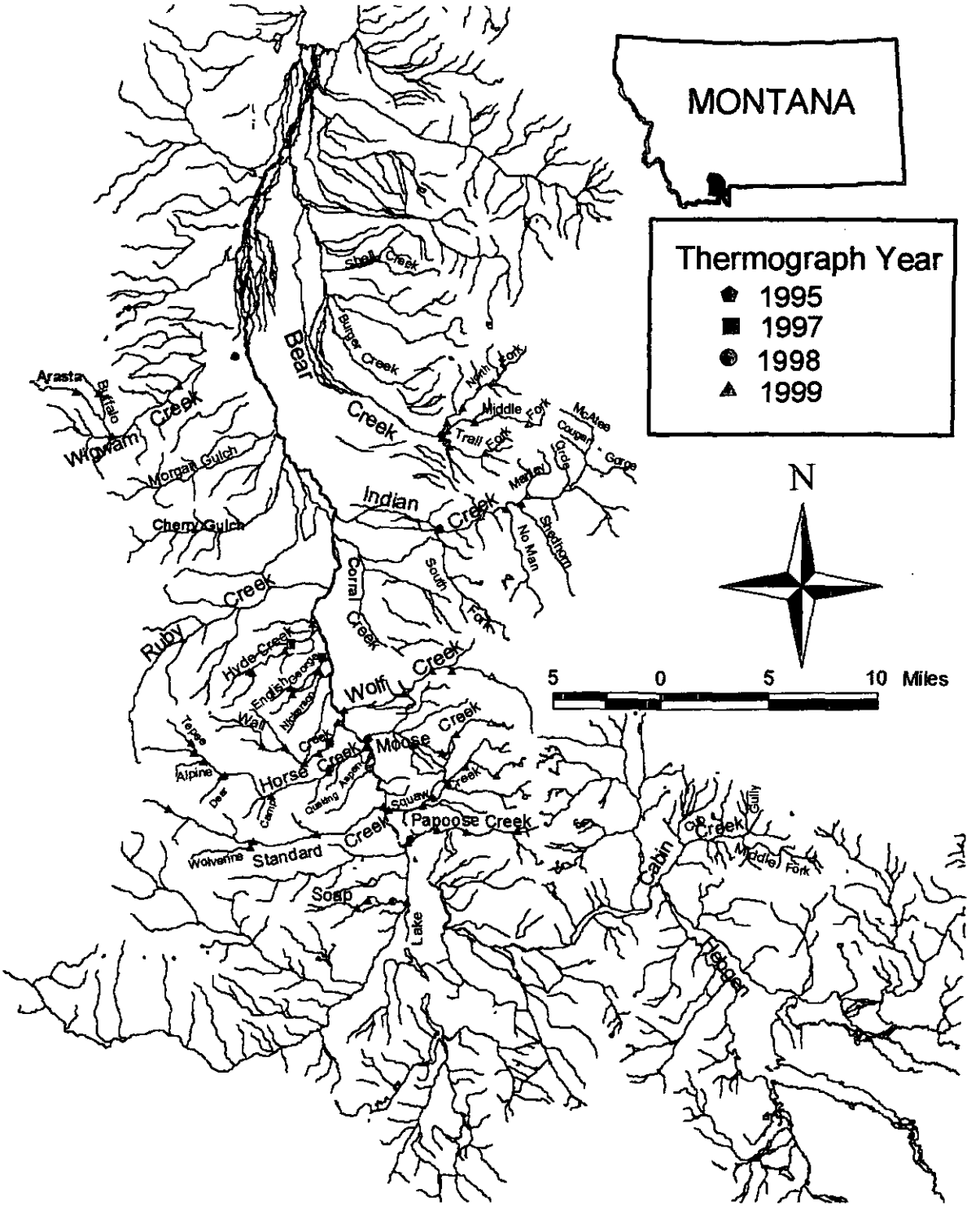

Figure 3. Location of thermograph recorders placed in Madison River tributaries from 1995 to 1999 by year.

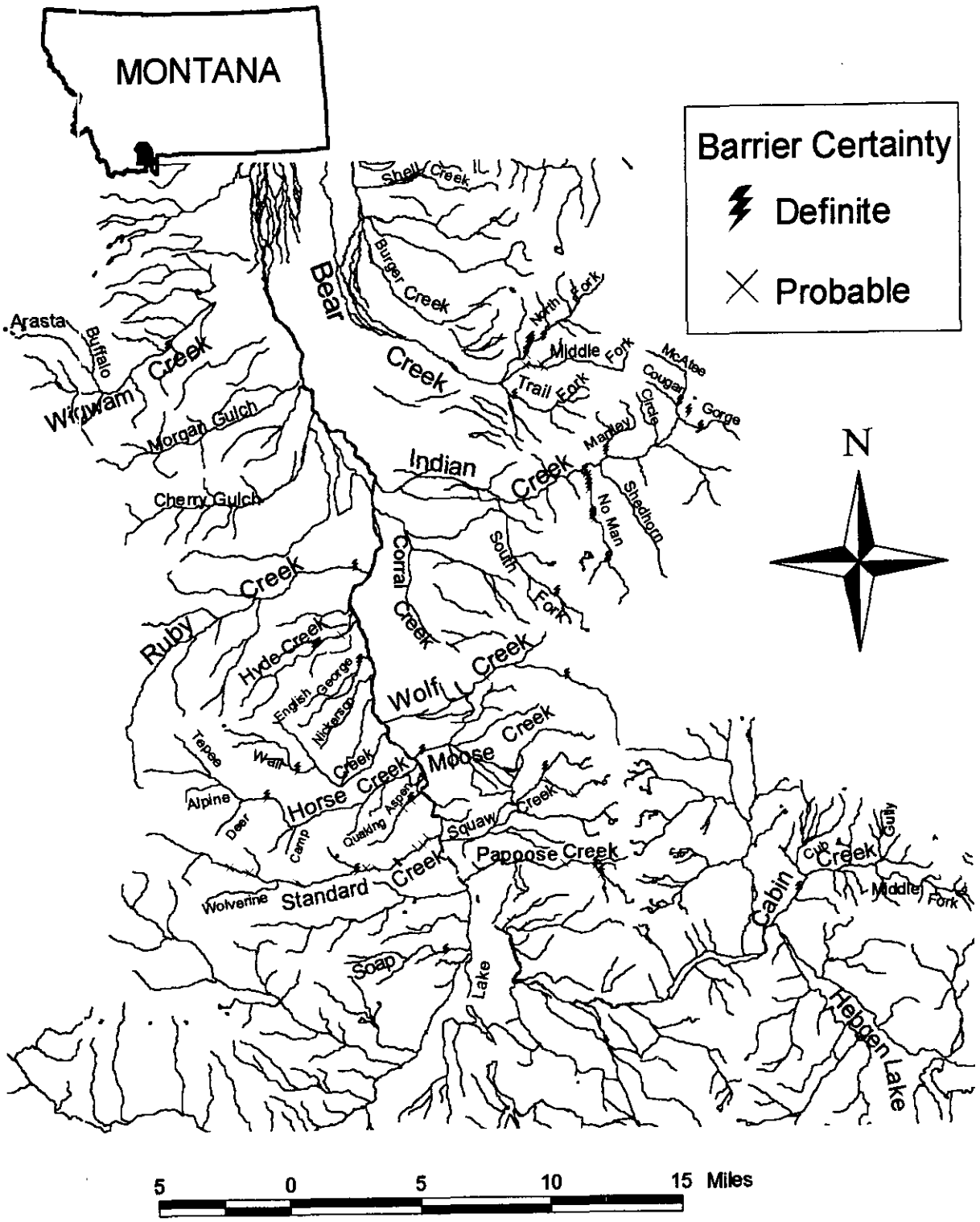

Figure 4. Location of known barriers to upstream fish movement in Madison River tributaries. Known barriers are classified as definite and probable.

During the summers of 1998 and 1999, Bear Creek was dry shortly downstream from the confluence of the forks of Bear Creek due to irrigation withdrawal. USGS 1:24000 maps show the Trail Fork of Bear Creek entering Bear Creek at stream mile 22.5, and depict the main stem of Bear Creek extending two miles upstream from the mouth of the Trail Fork (Figure 1). This stream channel for the main stem of Bear Creek does not exist. The Trail Fork of Bear Creek accounts for all of the water in Bear Creek upstream from the confluence with the Middle Fork of Bear Creek. For the purposes of this report we consider the stream above the confluence with the Middle Fork of Bear Creek to be the Trail Fork of Bear Creek. Likewise, we consider Bear Creek to begin below this confluence. Stream miles given for the Trail Fork of Bear Creek are measured from this confluence.

Habitat

Trail Fork of Bear Creek

An Onset Optic Stowaway® thermograph was place in the Trail Fork of Bear Creek on June 20, 1998 and left to record stream temperatures until October 20, 1998 (Figure 3). Stream temperatures were cold with an average temperature of 43.7° F (Figure 5). Stream temperatures fluctuated from <1.0 to 6.4° F daily, and never exceeded 50.0° F.

Onset Optic Stowaway® thermographs were placed in the Trail Fork of Bear Creek near the stream's mouth, and at stream miles 0.75, and 2.5 on July 1, 1999 and left to record stream temperatures until September 18, 1999 (Figure 6). Mean stream temperatures decreased in an upstream direction, ranging from 45.9 to 44.3° F (Figure 6). Stream temperatures fluctuated 1.4 to 9.8° F daily, with the greatest fluctuations occurring at the stream's mouth.

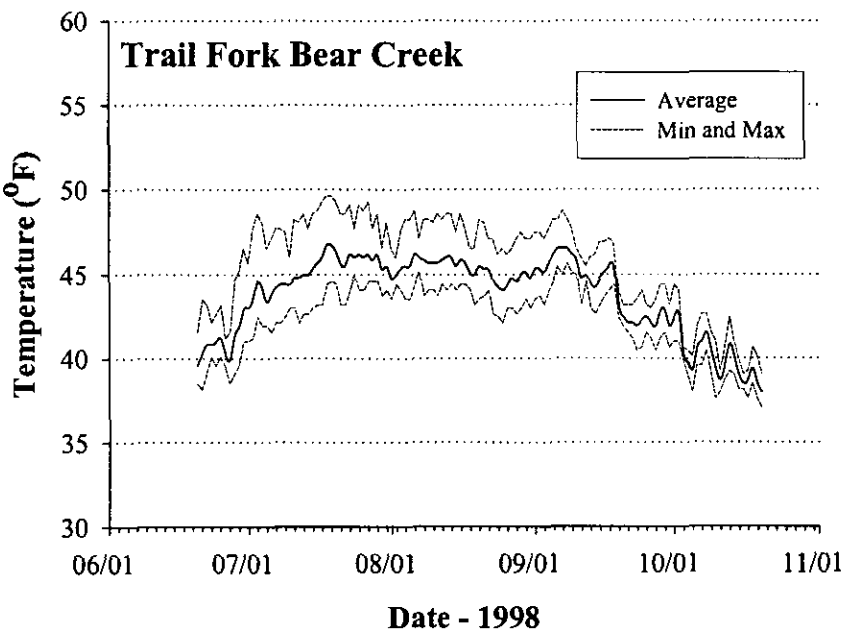

Figure 5. Average, minimum, and maximum daily water temperatures in the Trail Fork of Bear Creek near the stream's mouth during the summer of 1998.

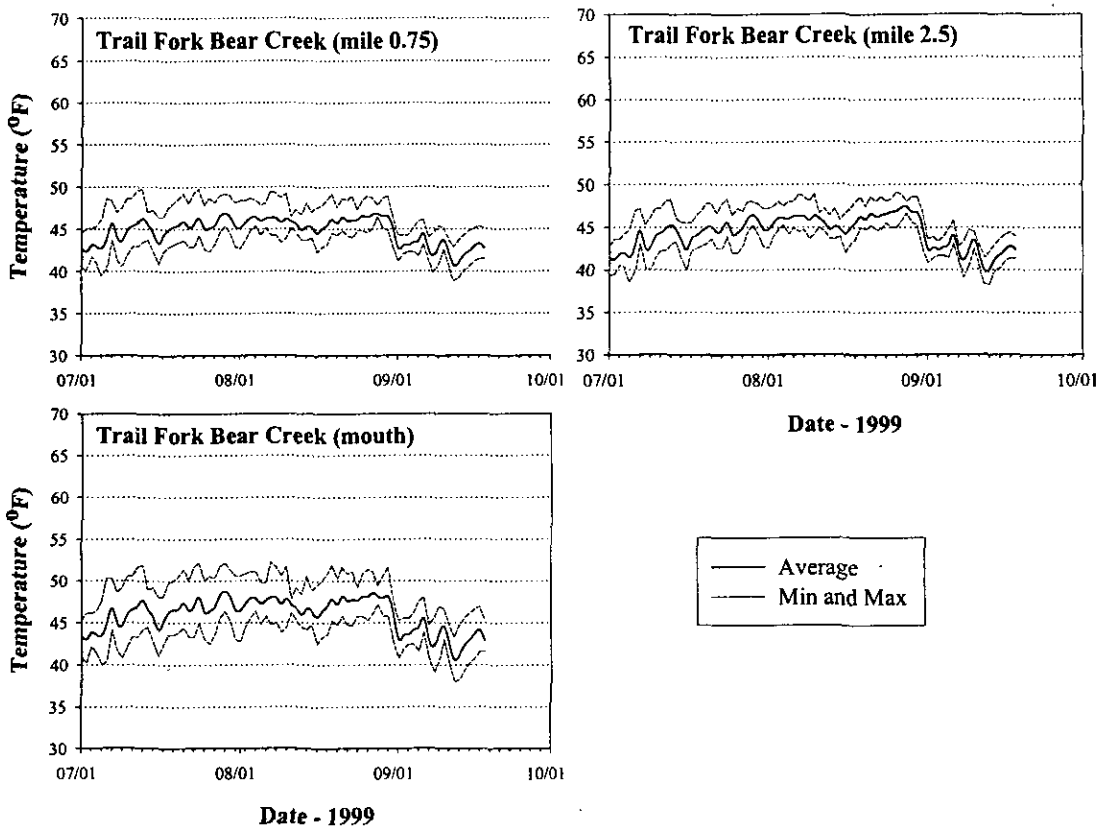

Figure 6. Average, minimum, and maximum daily water temperatures at three locations in the Trail Fork of Bear Creek during the summer of 1999.

Middle Fork of Bear Creek

An Onset Optic Stowaway® thermograph was placed in the Middle Fork of Bear Creek near the stream's mouth on June 20, 1998 and left to record summer stream temperatures (Figure 3). The thermograph became dewatered after August 23, however. Mean stream temperature for this period remained cool at 47.8° F (Figure 7). The maximum recorded temperature was 52.3° F. Stream temperatures fluctuated 3.1 to 10.6° F daily.

Onset Optic Stowaway® thermographs were placed in the Middle Fork of Bear Creek at stream mile 0.5, 1.75, and 3.0 on July 1 and left to record stream temperatures until September 18, 1999 (Figure 3). Mean summer temperatures were relatively cool, and decreased from 46.7° F at the lowest thermograph to 44.1° F at the highest thermograph (Figure 8). Maximum recorded temperatures also cooled in an upstream direction, ranging from 54.9 to 52.2° F. Stream temperatures fluctuated 2.2 to 13.1° F daily.

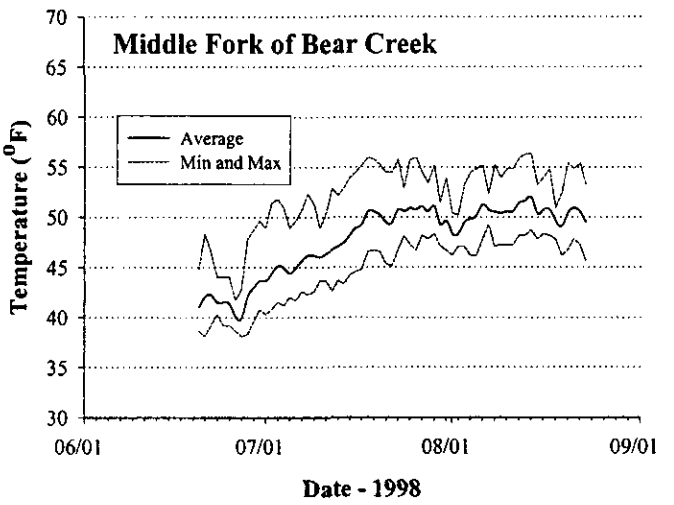

Figure 7. Average, minimum, and maximum stream temperatures in the Middle Fork of Bear Creek near the stream's mouth during the summer of 1998.

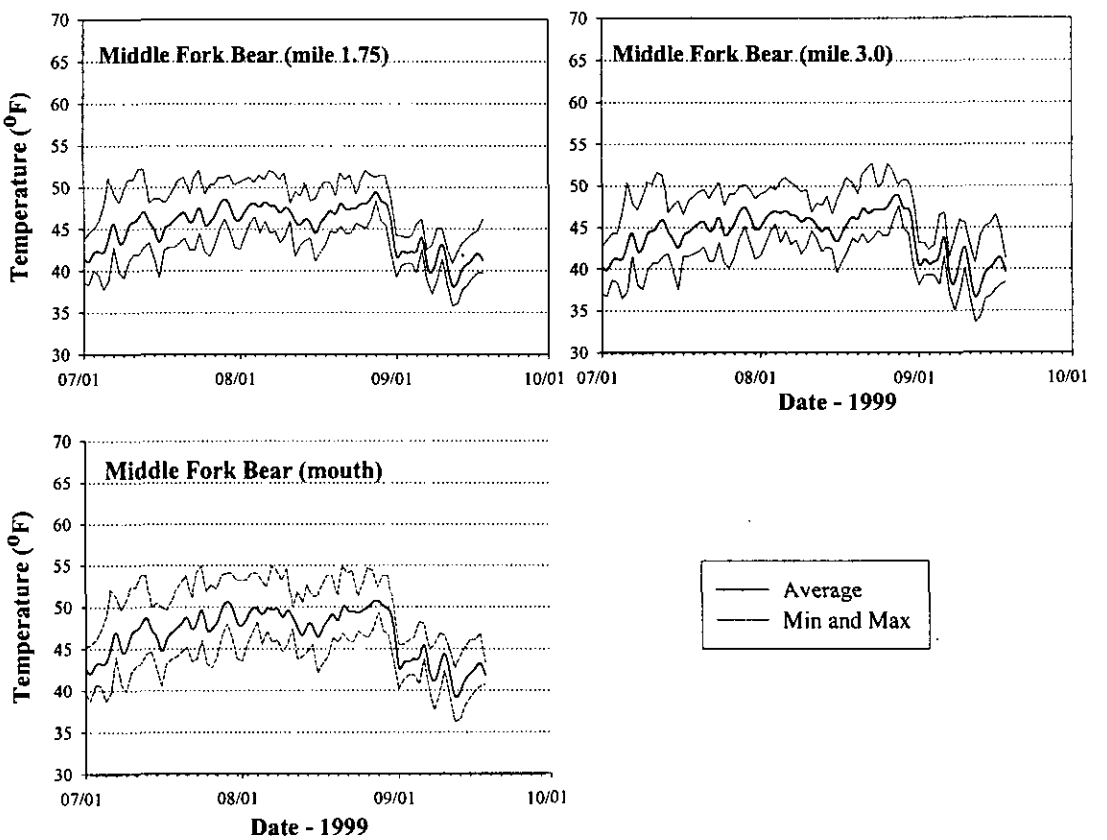

Figure 8. Average, minimum, and maximum stream temperatures at three locations in the Middle Fork of Bear Creek during the summer of 1999.

A 2.0 mile-long reach survey was conducted in the Middle Fork of Bear Creek from its confluence with the North Fork of Bear Creek upstream to the first unnamed tributary. A reach survey beginning at the first unnamed tributary and extending a half-mile upstream was also made. Riffle and pool habitat types dominated both reaches, comprising nearly equal proportions of the stream channel (Table 1). Within both reaches several large landslides and bank failures were responsible for poor streambank stability.

A detailed habitat survey was not conducted in the Middle Fork of Bear Creek because of the extremely low densities of fish. The fact that our sampling turned up so few fish was surprising since, aside from bank stability problems, the stream appeared to have quality habitat.

North Fork of Bear Creek

Onset Optic Stowaway® thermographs were placed in the North Fork of Bear Creek at stream miles 0.75, 2.0, and 3.75 on July 1 and were left to record stream temperatures until September 18, 1999 (Figure 3). Mean stream temperatures for this period were relatively cool, and decreased from 48.2°F at the lowest thermograph to 44.7°F at the highest thermograph (Figure 9). Maximum stream temperatures also decreased in an upstream direction, ranging from 57.9 to 54.9° F. Stream temperatures fluctuated from 2.2 to 16.2° F daily.

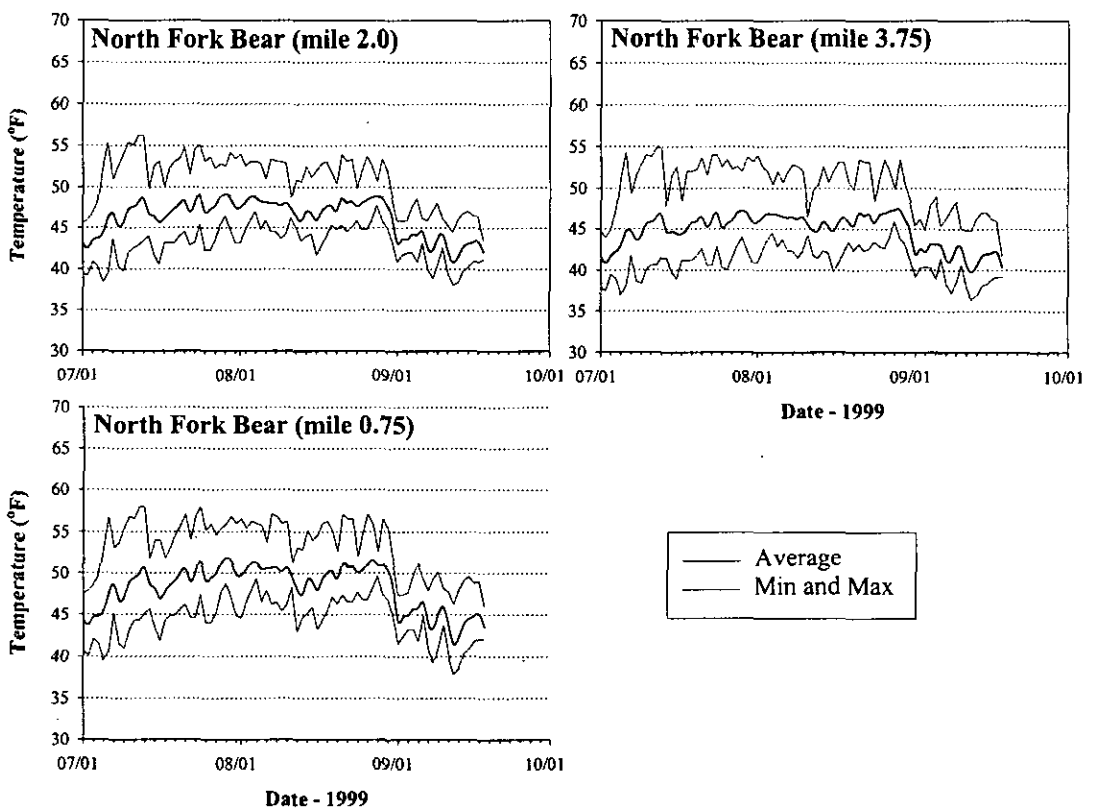

Figure 9. Average, minimum, and maximum stream temperatures at three locations in the North Fork of Bear Creek during the summer of 1999.

Table 1. Summary of reach survey data for number of habitat types counted and total number (%) of pool, riffle, and run habitat types.

Stream	Riffle Habitat Types				Pool Habitat Types								
					Dammed Types		Scour Types				Step		
Reach Code	Casc	High Gr	Low Gr	Total	Mid	Backwater	Lateral	Under	Mid	Plunge	pool	Total	Run
Bear Creek													
M98R01	47	96	17	160	0	0	20	0	5	82	35	142	25
				(49)								(43)	(8)
Circle Creek													
M98R02	9	84	41	134	1	0	14	0	2	33	7	57	25
				(62)								(26)	(12)
Corral Creek													
M98R03	42	41	5	88	0	0	21	0	4	34	8	67	13
				(52)								(40)	(8)
English George Cr													
ENGG	3	19	6	28	4		3			4	1	12	23
				(44)								(19)	(37)
Gorge Creek													
M98R04	7	18	2	27	0	0	6	0	0	13	0	19	3
				(55)								(39)	(6)
Horse Ck 10.0-9.5MI													
HOU10.09.5	0	6	16	22	1		22		2	3		28	23
				(30)								(38)	(32)
Hyde Creek													
HYD001C	107	31	1	139	48	0	5	0	0	35	7	95	0
				(59)								(41)	(0)
HYD001B	1	70	0	71	42	15	36	0	0	36	0	129	1
				(35)								(64)	(0)

Table 1. (continued).

Stream	Riffle Habitat Types				Pool Habitat Types								
					Dammed Types		Scour Types				Step		
Reach Code	Casc	High Gr	Low Gr	Total	Mid	Backwater	Lateral	Under	Mid	Plunge	pool	Total	Run
HYD001D	61	8	0	69 (55)	19	0	1	0	0	14	14	48 (38)	9 (7)
HYD001E	52	11	0	63 (46)	35	3	0	0	0	34	0	72 (53)	1 (1)
HYD001A	0	0	0	87 (30)	0	0	0	0	0	0	0	102 (35)	104 (35)
Indian Creek													
M98R05	10	300	72	382 (36)	3	0	285	0	23	99	13	423 (40)	259 (24)
M Fork Bear Creek													
M98R07	24	20	0	44 (43)	0	0	23	0	3	19	6	51 (50)	7 (7)
M98R06	109	126	3	238 (40)	5	0	115	0	45	80	39	284 (48)	70 (12)
McAtee Creek													
M98R08	39	195	57	291 (43)	2	0	102	0	33	90	49	276 (41)	105 (16)
N Fork Bear Creek													
M98R09	101	35	5	141 (44)	1	0	18	0	16	70	50	155 (48)	25 (8)
No Man Creek													
M98R10	109	213	47	369 (46)	7	1	67	0	28	181	49	333 (41)	106 (13)

Table 1. (continued).

Stream	Riffle Habitat Types				Pool Habitat Types								
					Dammed Types		Scour Types				Step		
Reach Code	Casc	High Gr	Low Gr	Total	Mid	Backwater	Lateral	Under	Mid	Plunge	pool	Total	Run
Quaking Aspen Ck													
QUASUNWE	67	36	0	103	21		14			86	68	189	54
				(30)								(55)	(16)
S Fk English George													
SFENGG1	0	64	175	242	1	0	44	0	0	0	3	48	3
				(83)								(16)	(1)
SFENGG2	61	86	30	180	16	0	9	0	0	21	14	60	3
				(74)								(25)	(1)
S Fork Indian Creek													
M98R11	47	47	11	105	1	0	13	0	9	39	22	84	4
				(54)								(44)	(2)
M98R12	12	42	39	93	0	0	36	0	3	21	6	66	15
				(53)								(38)	(9)
Standard Creek													
WOL TO 9.3	4	122	24	150	39	11	41		57	65	4	217	79
				(34)								(49)	(18)
WOL TO 3.8	8	99	6	113	20	1	13		32	17	7	90	10
				(53)								(42)	(5)
3.8TO MOUT	143	266	27	436	15		1		21	10	3	50	10
				(88)								(10)	(2)
Tepee Creek													
TEP1.0-0.5	1	15	18	34	2	3	9		4	22	8	48	8
				(38)								(53)	(9)

Table 1. (continued).

Stream	Riffle Habitat Types				Pool Habitat Types								
					Dammed Types		Scour Types				Step		
Reach Code	Casc	High Gr	Low Gr	Total	Mid	Backwater	Lateral	Under	Mid	Plunge	pool	Total	Run
Trib N of Gorge Cr													
M98R13	18	27	10	55	1	0	11	0	0	30	2	44	6
				(52)								(.42)	(6)
Wall Creek													
WAL 3.1-.0	40	169	26	235	54	0	1	0	26	14	9	104	29
				(64)								(28)	(8)
WAL5.0-3.0	206	94	14	314	35	8	6	0	0	209	9	267	72
				(48)								(41)	(11)
Wigwam Creek													
WIGBLMFA	8	27	2	37	2	2	3		2	11	4	24	17
				(47)								(31)	(22)

A reach survey was conducted in the North Fork of Bear Creek from the Lee Metcalf Wilderness Area boundary upstream approximately 1.0 mile to the first barrier falls (Figure 4). Riffle and pool habitat types dominated this reach, comprising nearly equal proportions of the stream channel (Table 1). Cascades dominated riffle types, while plunge scour pools and step pools dominated pool habitat types.

A detailed habitat survey was conducted in the North Fork of Bear Creek at stream mile 1.0. In this sample section the streambed was dominated by cobble and boulder substrate (Table 2). Both woody debris and spawning habitat were relatively abundant. Instream and bank cover, bank stability, and pool quality were all moderately high, and riparian habitats received limited use by wildlife (Table 3). The average wetted stream width was 13.9 feet, and the average water depth was 8.8 inches at this location (Table 4).

Fish Distribution and Abundance

Trail Fork of Bear Creek

A total of four westslope cutthroat trout were captured in an 846 foot-long sample section in the Trail Fork of Bear Creek at stream mile 0.5. Fin clips were taken from all fish captured in the Trail Fork for genetic analysis, but results are still pending. No fish were observed or captured in sample sections at the stream's mouth, or at stream miles 1.0, and 1.5 (Figure 10 and Appendix D). No other fish species were observed or captured in the Trail Fork of Bear Creek.

Middle Fork of Bear Creek

Based on external morphometric examination, fish captured in the Middle Fork of Bear Creek were identified as hybrids between rainbow trout and cutthroat trout. This identification is supported by results from electrophoretic analysis of two fish captured in the Middle Fork of Bear Creek in 1994. Alleles characteristic of both westlope cutthroat trout (87%) and rainbow trout (13%) were detected at the diagnostic loci analyzed among fish from the Middle Fork of Bear Creek (letter to Jim Brammer from Robb Leary dated May 23, 1995) (Table 5).

Rainbow-cutthroat trout hybrids were found in the lower portion of the Middle Fork of Bear Creek at stream miles 0.5 and 1.0 (Figure 10 and Appendix D). No other fish species were captured. At stream mile 0.5, four rainbow-cutthroat trout hybrids were captured in a 394 foot-long sample section. At stream mile 1.0, only one rainbow-cutthroat trout hybrid was captured in a 381 foot-long sample section. No fish were observed or captured at stream miles 1.5, and 2.0. A series of debris jams was located below these two sample sections, which may prevent upstream fish movement. However, the absence of fish upstream from these debris jams surprised us since, from our observations, the quality of stream habitat in the upper two sample sections was greater than the lower two.

Table 2. Streambed composition (%), frequency of small (< 6 inch) and large (>= 6 inch) in-channel and cross-channel woody debris per mile of stream length, and square feet of spawning habitat per mile of stream length by stream, section, and date.

STREAM		Streambed composition (% by class)						Frequency (#/mi) of woody debris				Square feet of spawning
								In-channel		Cross-channel		
Mile	Date	Bould	Cobble	Lg Grav	Sm Grav	Sand	Silt	Small	Large	Small	Large	habitat per mi
DRAINAGE: BEAR CREEK												
N FK BEAR CR												
1.0	08/03/1998	20	25	20	15	15	5	136.0	90.7	11.3	11.3	853.6
DRAINAGE: CABIN CREEK												
CABIN CREEK												
5.7	07/21/1994	5	40	30	15	5	5	0.0	0.0	0.0	0.0	441.8
M FK CABIN CREEK												
0.9	07/20/1994	20	40	15	10	10	5	121.5	124.5	0.0	17.8	325.3
2.3	07/19/1994	10	40	30	10	5	5	39.1	104.8	0.0	41.9	699.0
2.7	07/19/1994	5	40	35	10	5	5	0.0	0.0	0.0	0.0	654.6
3.1	07/19/1994	30	35	15	5	5	7	31.7	51.0	0.0	0.0	205.8
4.3	07/18/1994	3	25	35	10	5	12	47.8	0.0	0.0	0.0	165.7
S TRIB M FK CABIN CK												
0.0	07/19/1994	20	35	20	13	5	5	68.6	10.0	20.1	10.0	507.7
DRAINAGE: ENGLISH GEORGE CREEK												
ENGLISH GEORGE CR												
2.7	06/26/1997	20	10	5	15	25	25	1125.0	265.6	93.7	78.1	1378.6
S FK ENGLISH GEORGE CR												
1.5	06/26/1997	0	20	35	30	5	5	0.0	32.2	0.0	0.0	5662.5
DRAINAGE: HORSE CREEK												
HORSE CR												
5.5	07/30/1998	5	20	40	25	10	0	789.2	154.7	0.0	30.9	1581.8
7.0	07/30/1998	10	35	30	10	5	10	186.8	287.4	0.0	71.8	2659.3
8.0	07/28/1998	10	45	20	10	6	9	158.1	201.2	28.7	71.8	1082.3
8.5	07/28/1998	15	40	20	9	6	10	229.9	122.6	0.0	0.0	610.2
9.5	07/28/1998	5	20	35	25	5	0	0.0	0.0	0.0	0.0	1204.6
10.0	07/16/1997	5	45	25	25	5	5	410.2	173.6	0.0	31.6	1697.7

Table 2. (continued).

STREAM		Streambed composition (% by class)						Frequency (#/mi) of woody debris				Square feet of spawning
								In-channel		Cross-channel		
Mile	Date	Bould	Cobble	Lg Grav	Sm Grav	Sand	Silt	Small	Large	Small	Large	habitat per mi
TEPEE CR TRIB TO HORSE CR												
0.1	07/17/1997	3	35	35	14	10	3	772.5	402.3	0.0	96.6	1125.6
1.0	07/28/1998	2	5	10	10	13	60	263.1	0.0	0.0	0.0	0.0
DRAINAGE: HYDE CREEK												
HYDE CR												
3.5	07/02/1997	35	25	18	10	19	3	3218.7	414.3	350.6	79.7	634.4
DRAINAGE: INDIAN CREEK												
CIRCLE CR												
0.5	07/28/1998	20	25	25	15	5	10	96.6	64.4	16.1	48.3	692.7
CORRAL CR												
6.0	07/08/1998	5	15	40	30	5	5	449.9	103.8	86.5	51.9	2793.0
GORGE CR												
0.5	07/29/1998	20	35	25	10	5	5	254.8	321.9	26.8	134.1	577.2
INDIAN CR												
14.0	07/26/1998	10	20	25	10	15	20	128.7	209.2	0.0	32.2	1212.2
16.0	07/26/1998	5	15	10	55	5	10	244.9	87.5	70.0	70.0	3388.0
MCATEE CR												
0.5	07/28/1998	15	25	20	10	15	15	61.9	185.7	0.0	86.7	1465.2
2.0	07/27/1998	30	30	15	10	5	20	80.5	96.6	0.0	16.1	692.7
NO MAN CR												
2.5	08/17/1998	10	20	30	25	10	5	177.0	193.1	32.2	16.1	1385.3
4.0	08/19/1998	20	25	30	15	5	5	147.5	187.8	53.6	40.2	577.2
S FK INDIAN CR												
1.5	08/06/1998	5	15	45	30	4	1	147.5	254.8	13.4	40.2	3751.9
4.5	08/05/1998	15	20	15	10	9	1	64.4	32.2	0.0	32.2	1212.2

Table 2. (continued).

STREAM		Streambed composition (% by class)						Frequency (#/mi) of woody debris				Square feet of spawning
								In-channel		Cross-channel		
Mile	Date	Bould	Cobble	Lg Grav	Sm Grav	Sand	Silt	Small	Large	Small	Large	habitat per mi
DRAINAGE: MOOSE CREEK												
MOOSE CR												
0.3	07/19/1999	5	10	25	30	15	15	134.1	67.1	13.4	40.2	432.9
2.3	07/20/1999	5	30	35	25	10	5	154.1	68.5	51.4	51.4	2210.6
7.3	07/21/1999	10	5	20	10	50	50	11.5	46.0	0.0	0.0	1236.9
DRAINAGE: PAPOOSE CREEK												
PAPOOSE CR												
0.5	07/29/1999	15	20	25	25	10	5	64.9	272.6	0.0	64.9	837.9
3.0	07/26/1999	10	40	20	20	5	5	51.5	115.9	38.6	25.7	831.2
DRAINAGE: QUAKING ASPEN CREEK												
QUAKING ASPEN CR												
1.6	06/30/1998	10	25	25	25	10	5	170.4	37.9	18.9	37.9	1833.5
DRAINAGE: SQUAW CREEK												
MIDDLE FORK SQUAW CR												
2.5	08/11/1999	15	40	30	10	3	2	0.0	30.7	0.0	0.0	329.8
3.0	08/11/1999	20	40	20	10	3	2	0.0	78.1	0.0	0.0	672.5
SQUAW CR												
2.0	08/09/1999	10	20	30	25	10	5	25.7	64.4	0.0	0.0	1385.3
4.0	08/12/1999	5	40	30	20	3	2	133.0	106.4	13.3	26.6	715.6
6.0	08/10/1999	20	30	30	15	3	2	16.4	98.5	16.4	0.0	353.4
8.0	08/10/1999	20	10	25	20	15	10	18.9	0.0	0.0	0.0	1629.8
DRAINAGE: STANDARD CREEK												
STANDARD CR												
6.0	07/29/1997	10	60	25	5	0	0	96.6	32.2	0.0	0.0	2943.8

Table 2. *(continued).*

STREAM		Streambed composition (% by class)						Frequency (#/mi) of woody debris				Square feet of spawning
								In-channel		Cross-channel		
Mile	Date	Bould	Cobble	Lg Grav	Sm Grav	Sand	Silt	Small	Large	Small	Large	habitat per mi
DRAINAGE: WALL CREEK												
WALL CR												
3.0	07/08/1997	30	30	10	12	15	3	4425.7	482.8	80.5	80.5	1471.9
DRAINAGE: WIGWAM CREEK												
BUFFALO CR TRIB TO WIGWAM												
1.5	07/22/1997	5	70	10	5	5	5	160.9	32.2	0.0	32.2	1160.2
DRAINAGE: WOLF CREEK												
WOLF CR												
2.0	08/02/1999	30	20	20	20	5	5	53.6	40.2	0.0	13.4	721.5
4.0	08/03/1999	20	30	25	15	7	3	26.2	65.4	0.0	0.0	844.7
5.5	08/04/1999	10	30	30	20	7	3	13.1	183.2	0.0	91.6	1971.0

Table 3. Rankings (0 = none or lowest; to 9 = highest) of instream cover, bank cover, bank stability, and pool quality by stream, section, and date.

STREAM Mile	Date	Instream cover	Bank cover	Bank stability	Pool quality	Riparian use
DRAINAGE: BEAR CREEK						
N FK BEAR CR						
1.00	08/03/1998	7	6	6	7	2
DRAINAGE: CABIN CREEK						
CABIN CREEK						
5.7	07/21/1994	2	8	7	8	5
M FK CABIN CREEK						
0.9	07/20/1994	4	5	9	4	8
2.3	07/19/1994	2	5	6	5	8
2.7	07/19/1994	5	7	4	7	8
3.1	07/19/1994	5	6	6	5	8
4.3	07/18/1994	3	6	8	5	8
S TRIB M FK CABIN CK						
0.0	07/19/1994	5	7	9	5	8
DRAINAGE: ENGLISH GEORGE CREEK						
ENGLISH GEORGE CR						
2.70	06/26/1997	8	8	8	6	2
S FK ENGLISH GEORGE CR						
1.50	06/26/1997	5	5	5	5	4
DRAINAGE: HORSE CREEK						
HORSE CR						
5.50	07/30/1998	8	8	8	8	1
7.00	07/30/1998	5	5	8	6	1
8.00	07/28/1998	5	6	8	8	1
8.50	07/28/1998	6	6	7	7	1
9.50	07/28/1998	3	2	2	5	2
10.00	07/16/1997	3	7	8	7	2
TEPEE CR TRIB TO HORSE CR						
0.10	07/17/1997	7	7	8	7	3
1.00	07/28/1998	2	1	3	2	1
DRAINAGE: HYDE CREEK						
HYDE CR						
3.50	07/02/1997	9	9	8	7	3

Table 3. (continued).

STREAM Mile	Date	Instream cover	Bank cover	Bank stability	Pool quality	Riparian use
DRAINAGE: INDIAN CREEK						
CIRCLE CR						
0.50	07/28/1998	4	8	8	5	2
CORRAL CR						
6.00	07/08/1998	7	9	8	7	2
GORGE CR						
0.50	07/29/1998	7	7	5	8	2
INDIAN CR						
16.00	07/26/1998	5	6	4	5	3
14.00	07/26/1998	5	7	5	6	4
MCATEE CR						
0.50	07/28/1998	7	6	5	6	3
2.00	07/27/1998	7	4	5	9	3
NO MAN CR						
2.50	08/17/1998	6	8	7	7	2
4.00	08/19/1998	8	6	7	7	2
S FK INDIAN CR						
1.50	08/06/1998	4	8	7	8	5
4.50	08/05/1998	5	5	6	5	2
DRAINAGE: MOOSE CREEK						
MOOSE CR						
0.25	07/19/1999	8	10	8	4	0
2.25	07/20/1999	7	8	9	5	0
7.25	07/21/1999	4	8	7	7	2
DRAINAGE: PAPOOSE CREEK						
PAPOOSE CR						
0.50	07/29/1999	8	8	8	8	2
3.00	07/26/1999	5	6	5	4	4
DRAINAGE: QUAKING ASPEN CREEK						
QUAKING ASPEN CR						
1.60	06/30/1998	4	4	5	4	6
DRAINAGE: SQUAW CREEK						
MIDDLE FORK SQUAW CR						
2.50	08/11/1999	2	1	2	0	2
3.00	08/11/1999	4	5	5	7	1

Table 3. (continued).

STREAM Mile	Date	Instream cover	Bank cover	Bank stability	Pool quality	Riparian use
SQUAW CR						
2.00	08/09/1999	4	4	4	5	3
4.00	08/12/1999	6	5	5	5	2
6.00	08/10/1999	4	3	4	6	0
8.00	08/10/1999	4	5	9	3	1
DRAINAGE: STANDARD CREEK						
STANDARD CR						
6.00	07/29/1997	5	4	4	3	3
DRAINAGE: WALL CREEK						
WALL CR						
3.00	07/08/1997	8	9	9	9	1
DRAINAGE: WIGWAM CREEK						
BUFFALO CR TRIB TO WIGWAM						
1.50	07/22/1997	4	4	3	5	7
DRAINAGE: WOLF CREEK						
WOLF CR						
2.00	08/02/1999	5	7	6	4	1
4.00	08/03/1999	6	6	5	5	4
5.50	08/04/1999	8	7	8	8	2

Table 4. Total length (ft), average length (ft), average width (ft), average depth (in), and average volume (cubic feet) of each habitat type, and for pools the average thalweg depth (in), and residual pool volume (cubic feet) by stream and section.

STREAM Mile	Date	Habitat type	n	Total length (ft)	Average length (ft)	Average width (ft)	Average Depth (in)	Average volume (cu ft)	Average thalweg depth (in)	Residual pool volume (cu ft)
DRAINAGE: BEAR CREEK										
N FK BEAR CR										
1.00	08/03/1998									
		POOL	10	116.5	11.6	13.9	11.4	165.4	16.2	58.1
		RIFFLE	9	262.8	29.2	13.9	6.2	222.7		
		RUN	2	28.2	14.1	14.1	7.7	125.3		
		Section:	21	407.5	19.4	13.9	8.8			
DRAINAGE: CABIN CREEK										
CABIN CREEK										
5.7	07/21/1994									
		POOL		190.0	95.0	12.0	10.2	1063.3	19.7	1465.2
		RIFFLE		70.2	35.1	33.5	4.0	379.8	0.0	0.0
		RUN		74.1	74.1	17.7	7.8	853.3	0.0	0.0
		Section:		334.3	66.9	21.7	7.2			
M FK CABIN CREEK										
0.9	07/20/1994									
		POOL		35.4	11.8	11.0	6.9	76.1	13.0	86.8
		RIFFLE		227.0	25.2	11.1	4.7	116.4	0.0	0.0
		RUN		34.4	17.2	10.2	4.7	68.1	0.0	0.0
		Section:		296.9	21.2	11.0	5.2			
2.3	07/19/1994									
		POOL		50.5	16.8	9.4	8.0	102.3	19.3	188.9
		RIFFLE		121.7	24.3	10.8	2.6	64.9	0.0	0.0
		RUN		79.7	79.7	10.2	5.6	377.8	0.0	0.0
		Section:		252.0	28.0	10.3	4.7			
2.7	07/19/1994									
		POOL		75.1	25.0	8.4	7.1	124.3	19.6	263.6
		RIFFLE		133.2	26.6	10.1	2.7	64.9	0.0	0.0
		RUN		78.1	26.0	6.1	4.5	59.3	0.0	0.0
		Section:		286.4	26.0	8.6	4.4			

Table 4. (continued).

STREAM Mile	Date	Habitat type	n	Total length (ft)	Average length (ft)	Average width (ft)	Average Depth (in)	Average volume (cu ft)	Average thalweg depth (in)	Residual pool volume (cu ft)
S FK INDIAN CR										
1.50	08/06/1998									
		POOL	6	91.5	15.3	21.2	12.1	248.8	19.4	173.2
		RIFFLE	9	429.8	47.8	17.2	6.2	396.8		
		RUN	1	23.0	23.0	19.7	10.2	385.6		
		Section:	16	544.3	34.0	18.9	8.6			
4.50	08/05/1998									
		POOL	4	35.1	8.8	14.6	5.8	49.8	20.7	187.0
		RIFFLE	6	211.3	35.2	13.8	6.2	263.0		
		RUN	1	19.7	19.7	17.7	6.3	183.1		
		Section:	11	266.1	24.2	14.4	6.1			
DRAINAGE: MOOSE CREEK										
MOOSE CR										
0.25	07/19/1999									
		HGR	7	210.6	30.1	10.6	7.1	166.3		
		LGR	4	124.3	31.1	11.2	6.9	196.5		
		POOL	8	85.6	10.7	9.6	13.7	121.3	16.2	39.4
		RUN	8	143.0	17.9	9.5	10.2	146.6		
		Section:	27	563.6	20.9	10.1	10.0			
2.25	07/20/1999									
		HGR	1	76.8	76.8	12.8	5.9	483.4		
		Section:	1	76.8	76.8	12.8	5.9			
7.25	07/21/1999									
		LGR	1	62.3	62.3	26.2	5.9	805.2		
		RUN	2	383.9	191.9	9.5	17.1	4095.8		
		Section:	3	446.2	148.7	15.1	13.4			

Table 4. (continued).

STREAM Mile	Date	Habitat type	n	Total length (ft)	Average length (ft)	Average width (ft)	Average Depth (in)	Average volume (cu ft)	Average thalweg depth (in)	Residual pool volume (cu ft)
DRAINAGE: PAPOOSE CREEK										
PAPOOSE CR										
0.50	07/29/1999									
		HGR	5	229.3	45.9	16.3	9.3	549.5		
		LGR	1	36.7	36.7	15.4	8.7	409.0		
		POOL	3	33.5	11.2	17.6	21.9	358.5	23.0	158.7
		RUN	3	62.0	20.7	11.2	11.2	229.2		
		Section:	12	361.5	30.1	15.3	12.9			
3.00	07/26/1999									
		HGR	4	259.2	64.8	15.7	9.4	724.6		
		LGR	1	45.9	45.9	14.4	8.7	478.6		
		POOL	3	33.1	11.0	11.5	16.0	164.9	20.1	55.8
		RUN	1	7.9	7.9	10.5	11.0	75.9		
		Section:	9	346.1	38.5	13.6	11.7			
DRAINAGE: QUAKING ASPEN CREEK										
QUAKING ASPEN CR										
1.60	06/30/1998									
		POOL	8	47.6	5.9	6.4	7.6	23.4	7.8	9.1
		RIFFLE	10	127.3	12.7	7.2	3.3	23.9		
		RUN	4	45.6	11.4	4.8	4.1	18.4		
		Section:	22	220.5	10.0	6.5	5.0			
DRAINAGE: SQUAW CREEK										
MIDDLE FORK SQUAW CR										
2.50	08/11/1999									
		HGR	1	344.5	344.5	9.2	5.5	1453.6		
		Section:	1	344.5	344.5	9.2	5.5			
3.00	08/11/1999									
		HGR	5	202.8	40.6	13.5	8.5	386.2		
		POOL	6	46.3	7.7	11.9	15.6	122.0	17.7	39.4
		Section:	11	249.0	22.6	12.6	12.4			

Table 5. Genetic testing results for sites in the Madison River drainage by date (year, month, day), legal description, sample size (n), and analysis method (E = allozyme electrophoretic and P = PINE DNA) showing species code (RB = rainbow trout; WCT = westslope cutthroat trout; and YCT = Yellowstone cuthroat trout) and proportion of sample estimated to contain alleles of each species, and, where applicable, number of individuals that were pure. Information from the Montana Resource Information System database unless otherwise denoted.

STREAM			Analysis	Genetic results (species code and %)						Number pure
Date	Legal (TRSec)	n	method	Code	%	Code	%	Code	%	WCT
ANDERSON CR										
19910801	12S03W24B	5	E	WCT	85	RB	150			
ARASTA CR										
19950726	07S03W36[a/]	5	E	WCT	100					5
19990720	08S02W06AC[k/]	1	P	Hybrid between WCT and YCT						
BUFFALO CR										
19950726	07S02W 31[a/]	4	E	WCT	100					4
19990720	08S02W 05CC[k/]	7	P	WCT	84	YCT	12	RB	4	
19990720	07S02W 31DD[k/]	7	P	Same as above (samples combined)						
BUFORD CR										
19910601	12S02W20D	5	E	WCT	92	RB	8			0
19910801	12S02W29A	5	E	WCT	92	RB	8			0
CABIN CR										
19970831	11S04E 05	7	E	WCT	100					7
19981115	11S03E [redacted] 15	8	E	RB	71	YCT	29			
19990419	11S03E 14	10	P	WCT	93	RB	7			
19990726	5 sites from falls to meadow below forks	27	P	WCT	96	RB	4			
19990727	11S04E 05	6	P	Uncertain, RB character at 1 allele in 1 fish						
CABIN CR, M FK										
19930601	11S04E11	10	E	WCT	100					10
19990727	6 sites – all	58	P	WCT	98	RB	2			
CORRAL CR										
19980708	Mile 6.0[j/]	21	P	WCT	86	RB	8	YCT	6	0
ENGLISH GEORGE CR										
19920801	09S01W36C	15	E	WCT	95	RB	5			0
19970626	10S01W02[d/]	3	E	WCT						
19990608	10S01W02AC[k/]	10	P	WCT Uncertain, probably pure WCT, but a single allele characteristic of RB seen (maybe deviant)						
ENGLISH GEORGE CR, S FK										
19970701	10S01W10[d/]	1	E	WCT						
19990608	10S01W02CA[k/]	9	P	WCT uncertain, one allele that is deviant for YCT and another for RB						

Table 5. (continued).

STREAM Date	Legal (TRSec)	n	Analysis method	Genetic results (species code and %) Code	%	Code	%	Code	%	Number pure WCT
GAZELLE CR										
19910901	11S01W23B	10	E	YCT	100					10
HORSE CR										
19950810	10S02W19C[a/]	8	E	WCT	100					8
19970730	10S01W25[d/]	20	E	WCT						
19980728	Mile 4.5-7.0[e/]	70	P	WCT	88	YCT	9	RB	3	0
19980728	Mile 7.5-8.5[e/]	29	P	WCT	98	YCT	2			0
HYDE CR										
19950721	09S01W34[b/]	3	E	WCT	96	RB	4			0
19970702	09S01W28[f/]	2	E	WCT		YCT				
19990713	09S01W33BB[k/]	16	P	WCT	96	YCT	4			
MADISON R, W FK										
19910601	12S03W14A	3	E	WCT	94	RB	6			0
MERIDIAN CR										
19910901	12S01E 30	5	E	WCT	75	RB	25			0
MIDDLE FORK BEAR CR1										
19940727	07S02E 06[l/]	2	E	WCT	87	RB	13			0
MILE CR										
19950907	12S02E24A	10	E	WCT	64	RB	28	YCT	8	0
NORTH FORK BEAR CR										
19940726[l/]		4	E	WCT	70	RB	25	YCT	5	0
PAPOOSE CR										
19940726	11S02E06	4	E	WCT	100					4
19990727	Miles 0.5, 1.0, 1.5, 2.0, 2.5, 3.0,and 3.5[k/] or3.0 , 11S01E Secs 10, 02, and 01 AND 11S02E Sec 06		P	Some pure WCT (6 of 9) were found at mile 2.5, and 3.5. All fish below mile 2.5 were either rainbow (3 of 15) or hybrids. The three hybrids above mile 2.5 were hybridized with RB at a single allele (could be deviant and still pure WCT).						
QUAKING ASPEN CR										
19980630	Mile 1.0[g/]	16	P	WCT	77	RB	23			0
19980630	Mile 2.0[g/]	3	P	WCT		RB				0
RED CANYON CR										
19890811	11S04E26A	25	E	WCT	50	YCT	48	RB	2	0
SHEEP CR										
19950907	12S02E01D	3	E	RB	75	YCT	11	WCT	10	0
SOAP CR										
19910919	11S01E29A	12	E	WCT	99	YCT	0.9			0
19920901	11S01E29A	16	E	WCT	99	YCT	0.6			0
SOUTH FORK INDIAN CREEK										
19980805	Mile 1.0 to 3.5[h/]	34	P	WCT	79	RB	15	YCT	6	0

Table 5. (continued).

STREAM Date	Legal (TRSec)	n	Analysis method	Genetic results (species code and %) Code	%	Code	%	Code	%	Number pure WCT
STANDARD CR										
19970811	11S01E05,06[f]	13	E	WCT		YCT				
SULLIVAN CR										
19950801	06N06W25[a]	9	E	WCT		YCT				
TEPEE CR										
19950801	10S02W13[a]	5	E	WCT	100					5
19980728	Mile 1.0	13	P	WCT	98	YCT	2			0
TEPEE CR										
19910901	12S01W24B	5	E	WCT	85	RB	15			0
WALL CR										
19950815	10S01W23[b]	8	E	WCT[c]		RB				
19970709	10S01W 23[d]	3	E	WCT						
19990713	10S01W 23CA[k]	7	P	Uncertain, probably pure WCT, only one fish had a single allele charateristic of YCT						
WALL CR, N FK										
19970709	10S01W 22[d]	6	E	WCT						
WIGWAM CR										
19970722	08S02W07,08[f]	7	E	WCT		YCT				
19980819	Mile 5.5[i]	3	P	WCT		YCT				0
19990720	08S02W07CA[k]	7	P	WCT	82	YCT	17	RB	1	0

[a] Information from letter to Jim Brammer from Robb Leary dated May 6, 1997.

[b] Information from letter to Jim Brammer from Robb Leary dated April 6, 1998.

[c] A single allele indicated the presence of Yellowstone cutthroat trout in this sample. It may be a pure westslope cutthroat trout population with a single deviant allele that is similar to Yellowstone cutthroat trout. Additional sampling is necessary.

[d] Information from letter to Brad Shepard from Naohisa Kanda and Robb Leary dated November 2, 1998. A freezer malfunction made it impossible to detect differences between westslope cutthroat trout and rainbow trout alleles, so these populations should be sampled again.

[e] Within the Horse Creek drainage (Horse and Tepee creeks) all fish were hybridized between westslope cutthroat, Yellowstone cutthroat, and rainbow trout, however, the population above a waterfall near stream mile 7.5 did not contain any rainbow trout alleles, had what may have been a few pure westslope cutthroat trout individuals, and had a higher proportion of westslope cutthroat trout alleles than the population below the falls (letter to Brad Shepard from Naohisa Kanda dated November 8, 1999).

[f] Information from letter to Brad Shepard from Naohisa Kanda and Robb Leary dated November 2, 1998. A freezer malfunction made it impossible to detect differences between westslope cutthroat trout and rainbow trout alleles, so these populations should be sampled again. However, some Yellowstone cutthroat trout introgression was documented.

[g] In Quaking Aspen Creek there were 7 individuals at Mile 1.0 that appeared to be pure westslope cutthroat trout, two individuals that appeared to be first-generation hybrids between rainbow and westslope cutthroat trout, and 7 appeared to be later-generation hybrids (letter to Brad Shepard from Naohisa Kanda dated November 8, 1999).

[h] Fish from the South Fork Indian Creek were all classified as hybrids between westslope cutthroat, rainbow, and Yellowstone cutthroat trout, however, fish from stream mile 2.5 to 3.5 contained over 90% westslope cutthroat trout alleles, while fish from lower in the drainage contained much lower westslope cutthroat trout allele frequencies (letter to Brad Shepard from Naohisa Kanda dated November 8, 1999).

[j] Fish from Corral Creek were all hybrids between westslope cutthroat, rainbow, and Yellowstone cutthroat trout (letter to Brad Shepard from Nachisa Kanda dated November 8, 1999).

[k] Letter from Naohisa Kanda to Brad Shepard dated March 27, 2000.

[l] Information from letter to Jim Brammer from Robb Leary dated May 23, 1995.

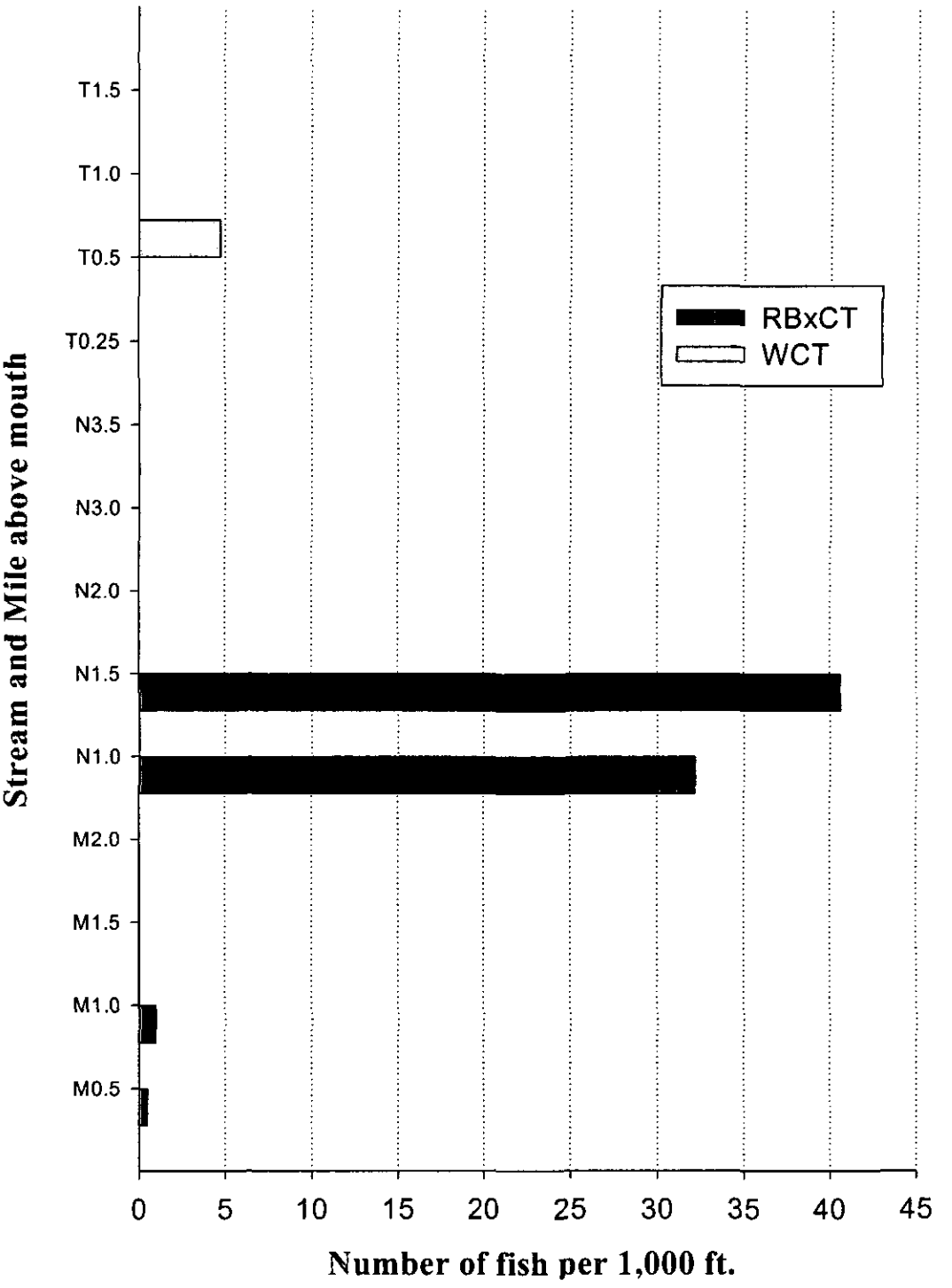

Figure 10. Catch of westslope cutthroat trout (WCT) and hybrids between rainbow trout and cutthroat trout (RBxCT) 3 inches and longer per 1000 feet of stream captured in the Trail (T and stream mile), Middle (M and stream mile), and North (N and stream mile) forks of Bear Creek during 1998. All sites shown on y-axis were sampled and zero values indicate no fish were captured

North Fork of Bear Creek

Fish captured in the North Fork of Bear Creek were also identified as hybrids between rainbow trout and cutthroat trout based on external morphometric examination. This identification is supported by results from electrophoretic analysis of four fish captured in the North Fork of Bear Creek in 1994. Alleles characteristic of both westlope cutthroat trout (70%), rainbow trout (25%), and Yellowstone cutthroat trout (5%) were detected at the diagnostic loci analyzed among fish from the North Fork of Bear Creek (letter to Jim Brammer from Robb Leary dated May 23, 1995) (Table 5).

Rainbow-cutthroat trout hybrids were captured in the North Fork of Bear Creek at stream miles 1.0, and 1.5. Sculpin were also captured in the North Fork of Bear Creek below the first barrier falls. Relative abundances of rainbow-cutthroat trout hybrids were moderately high in sample sections where they were captured, ranging from an estimated 35 trout per 1,000 feet of stream at stream mile 1.0 to 41 trout per 1,000 feet of stream at stream mile 1.5 (Figure 10 and Appendix D). No fish were observed or captured in sample sections at stream miles 2.0, 3.0, and 3.5, above the first barrier falls.

A three-pass depletion estimate was made at stream mile 1.0. The 466 foot-long sample section supported an estimated 26 (SE: 1.8) trout, with 9 of these fish (SE: 2.6) between 3 and 6 inches in length, 16 (SE: 0.72) between 6 and 12 inches, and 1 fish greater than 12 inches (Appendix E). This estimate translates to approximately 56 rainbow-cutthroat trout hybrids greater than 3 inches per 1000 ft of stream.

Fish Length and Weight

Westslope cutthroat trout captured in the Trail Fork of Bear Creek ranged from 6.1 to 6.7 inches long, with an average length of 6.3 inches (Figure 11 and Appendix F). Rainbow-cutthroat trout hybrids captured in the Middle Fork of Bear Creek ranged from 3.7 to 9.1 inches in length, with an average length of 6.7 inches. Rainbow-cutthroat trout hybrids captured in the North Fork ranged from 2.7 to 13.8 inches in length, with an average length of 8.4 inches.

Comparison to Previous Sampling

Besides the genetic status of fish in the North and Middle forks of Bear Creek summarized above, there are no records for the North, Middle, and Trail forks of Bear Creek in Montana Resource Information System (MRIS) database, nor from catalogued reports.

Burger Creek

Burger Creek is one of several small spring-fed streams draining the Madison Range south of Mill Creek and north of Bear Creek. Burger Creek was dry during the 1998 sampling season. A single pass electrofishing effort was made at stream mile 1.0 in an unnamed stream just north of Burger Creek. No fish were observed or captured in the 250 foot-long sample section. It is likely that all of the small, spring-fed streams in the general vicinity of Burger Creek are too small to support resident fish populations.

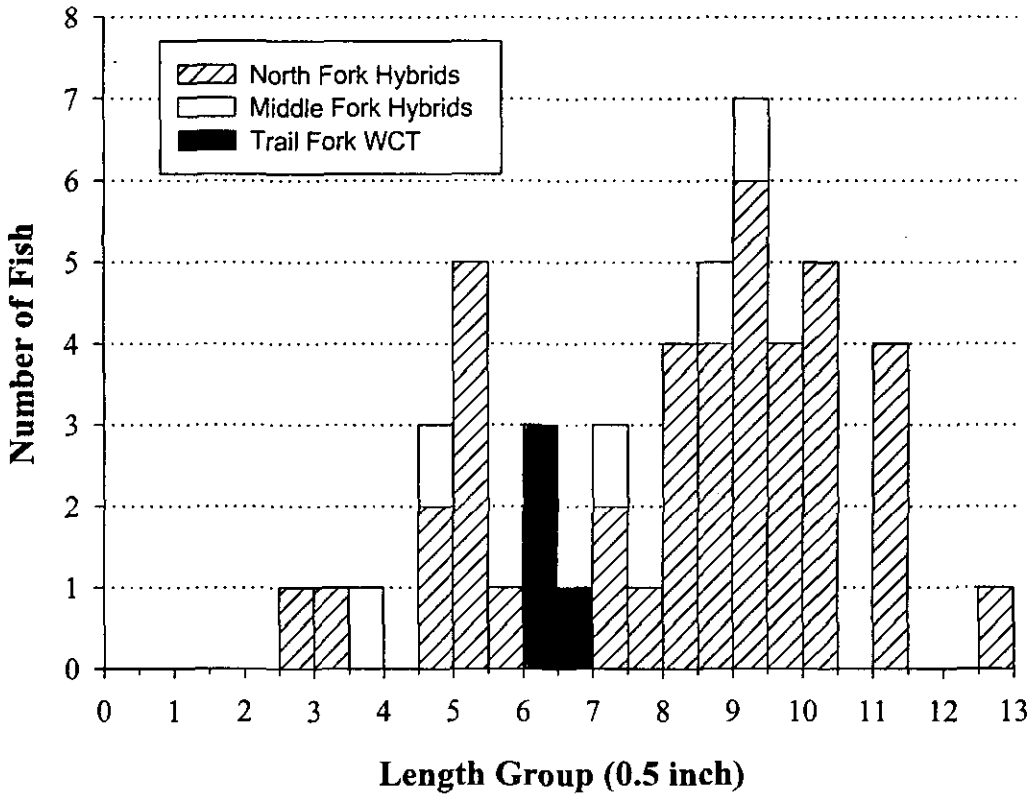

Figure 11. Length frequencies for westslope cutthroat trout (WCT) captured in the Trail Fork of Bear Creek, and hybrids between rainbow trout and cutthroat trout captured in the Middle and North forks of Bear Creek during 1998.

Cabin Creek Drainage

Cabin Creek originates from the Skyline Ridge of the Madison Range and flows southwest for about 7.7 miles before entering the Madison River from the north between Hebgen Lake and Quake Lake reservoirs (Figure 1). Cabin Creek drains lands administered by the Gallatin National Forest and lies within the Cabin Creek Wildlife Management Area, an area managed primarily for wildlife and primitive recreation. Gully Creek enters main Cabin Creek from the north at about stream mile 5.9, the Middle Fork of Cabin Creek enters from the south at about stream mile 5.8, Forest Creek enters Cabin Creek from the south at about stream mile 4.0, and Cub Creek enters from the north at about stream mile 2.5. Gully Creek is about 1.5 miles long. The Middle Fork Cabin Creek is about 5.1 miles long, Forest Creek is about 2.0 miles long, and Cub Creek is about 3.2 miles long. The South Fork of Cabin Creek enters the Middle Fork from the south at about stream mile 0.7. The South Fork is about 2.7 miles long. Two named lakes, Juncus and Axolotl, and numerous unnamed lakes and ponds lie within the drainage.

The Middle Fork flows through open high elevation meadows, mixed with a few short areas of confined valley containing conifer forest, in its upper reaches (about mile 1.0 up to its headwaters) before entering a very steep narrow canyon. It cascades for almost a mile through this narrow canyon, then flows through a meadow for about 0.1 mile before entering main Cabin Creek.

The Montana FWP fish-planting database indicated that 34,500 undesignated cutthroat trout fry were planted into Cabin Creek in 1932 (Appendix G). No other records of fish plants into streams or lakes within the Cabin Creek drainage could be found.

Sampling was conducted in 18 locations in the Cabin Creek drainage including main Cabin Creek; South Fork Cabin Creek; Middle Fork Cabin Creek; Gully Creek; and many unnamed tributaries. The unnamed tributaries were located just above Gully Creek in main Cabin Creek (section CT1); a south tributary of Middle Fork Cabin Creek (sections MFST1 and MFST2); a north tributary of Middle Fork Cabin Creek (sections MFNT1 and MFNT2); a forked tributary to Middle Fork Cabin Creek entering from north just below Forest Service cabin (sections MFFT1 and MFFT2); a spring tributary entering Middle Fork Cabin Creek from the north just below the Forest Service cabin (Section MF2NT); a spring tributary entering Middle Fork Cabin Creek from the south near South Fork Cabin Creek (Sections SFSP1 and SFSP2); a spring tributary entering the Middle Fork from the south near the pond (MFT1); and a small spring tributary entering Middle Fork Cabin at stream mile 3.8 (MFSP1).

Habitat

Cabin Creek

Gallatin Forest fisheries staff surveyed main Cabin Creek in 1999 (McClure 2000). Lower Cabin Creek, from its mouth up to Cub Creek was dominated by high gradient riffles interspersed with a few large, high-quality pools formed by aggregates of woody debris or large boulders. About 1000 feet of channel about 0.3 miles above the Cabin Creek Campground flows through the Hebgen Fault Scarp. Immediately following the 1959 earthquake a 21-foot waterfall was created just above the campground, but this falls has since eroded to a cascade area. A 10 to 12 foot high bedrock waterfall was found near stream mile 2.0 (below Cub Creek). This waterfall was believed to be a total barrier to upstream fish movement (Figures 3 and 12). From Cub Creek up to Gully Creek the channel was a Rosgen (1994) B3 channel type for the lower 1.5 miles, where it flowed through a meadow area near Cub Creek. The channel in this portion of the reach contained more habitat complexity than the lower portion of Cabin Creek. Areas of pocketwater and more woody debris were observed in this portion of the channel. The woody debris was in aggregates of 5 to 10 logs and these debris aggregates created numerous lateral pools. About 0.3 miles above Forest Creek the channel flows against a large landslide to the north that contributes large amounts of sediment to the channel. Channel gradients increase to form a cascading type of channel from this point upstream to the lower end of Shank's Meadow (below the confluence of the Middle Fork). While much of this steep A2 channel consisted of cascades and small vertical drops (2-4 ft.) no barrier was observed in this portion of the channel. Upstream of the steep, cascading section the channel flows for about 1.0 mile through a B3 channel type that contains

Figure 12. Barrier falls in main Cabin Creek located near stream mile 2.0, below Cub Creek.

relatively high quality fish habitat. In Shank's Meadow the channel is a C4/C3 type dominated by low gradient riffles interspersed with lateral scour pools.

A detailed habitat survey was conducted at mile 5.7 in main Cabin Creek. The substrate in main Cabin Creek below the Middle Fork (at mile 5.7) is dominated by cobble and large gravel material (Table 2). No woody debris was found in the stream channel at this site. Spawning habitat was adequate at this site. Instream cover was very limited and this area appeared to have been slightly impacted by either human or ungulate (probably outfitter horses and wildlife) use in the meadow near the mouth of the Middle Fork (Table 3). An outfitter camp was seen in this area and may account for some of the use impacts observed. Bank cover and stability and pool quality were all relatively high. Pool habitats made up over half the available habitat in this section (Table 4). The average wetted width was 21.7 feet and the average water depth was 7.2 inches.

Cub Creek

Gallatin National Forest fisheries staff surveyed Cub Creek (McClure 2000). They found that lower Cub Creek (up to mile 0.5) was dominated by high gradient riffles. A few slow water habitats, pools and runs, were formed by debris aggregates damming the flow. A short reach of high gradient containing numerous cascades and a waterfall was seen near stream mile 0.5. The waterfall is probably a barrier to upstream movement of fish. Above this high gradient area, the channel gradient lessens considerably in a 500 foot-long meadow area and is a C4 channel type.

Above this meadow the channel reverts to a B2/B3 channel type with high gradient riffles and cascades dominating the channel.

Forest Creek

Gallatin National Forest fisheries staff surveyed Cub Creek (McClure 2000). They found that the lower portion of Forest Creek was extremely high gradient with many vertical drops that were likely barriers to upstream fish movement. Middle Forest Creek flows through a meadow that was a C4 channel type.

Middle Fork Cabin Creek

The entire channel of the Middle Fork was walked to look for barriers to fish movement and assess habitat quality. The lower canyon portion of the Middle Fork contained numerous cascading sections that might be barriers to upstream fish passage, but no obvious barriers were observed. Most of the habitat in the Middle Fork was in good condition and, while pools were somewhat limited, there appeared to be enough pool habitats to hold fish. Spawning habitat was not deemed to be limiting. The channel in the upper portion of the drainage near the Forest Service cabin was so small that its ability to support fish was deemed marginal.

Detailed habitat surveys were conducted at miles 0.9, 2.3, 2.7, 3.1, and 4.3 in the Middle Fork of Cabin Creek and right at the mouth of an unnamed tributary that enters the Middle Fork from the south near mile 3.1. In the Middle Fork Cabin Creek cobble dominated the substrate in all five sections (Table 2). Boulders made up a relatively high proportion of the streambed at miles 0.9 and 3.1, while large gravel was the next most dominant substrate type in the other three sections. Woody debris were present in the lower two sections, but was absent from the upper three sections. Spawning gravel was abundant at miles 2.3 and 2.7, adequate at mile 0.9, and somewhat sparse in the upper two sections. Instream cover was rated as low to moderate in all five sections, while wildlife appeared to have impacted shrubs along the stream in all sections (Table 3). Stream banks were extremely stable in the lower-most and upper-most sections, but were only moderately stable in the middle sections. Bank cover was ranked as moderate in most sections and pool quality was low-to-moderate in the lower two sections, moderate-to-high in the middle section, and moderate in the upper two sections. Pool habitats made up less than 30% of the total habitat length in the five sections of the Middle Fork (Table 4). Average wetted widths were less than 5 feet in the upper sections and about 10 feet in the lower sections. Average water depths decreased from about 5 inches in the lower section to about 3 inches in upper sections.

Cobbles, boulders, and large gravel made up most of the streambed within the lower portion of the south tributary that enters the Middle Fork near mile 3.1 (Table 2). This tributary contained some woody debris within its channel near its mouth and debris was observed to be very abundant about half a mile above its mouth during an ocular survey. Spawning habitat was common in the sample site near the mouth. Pool habitats made up about 25% of the length of the sample section (Table 4). The average wetted width was 5.2 feet and the average depth was 3.7 inches.

South Fork Cabin Creek

Gallatin National Forest fisheries staff surveyed Cub Creek (McClure 2000). They found that the this stream had a very steep (>30%) reach of 400 feet immediately above the Middle Fork where they observed numerous vertical falls that they believed were barriers to upstream fish movement into the South Fork. Above this short high-gradient reach the stream flows through meadows with low channel gradients that contain a high frequency of pool habitats (26/1,000 ft.). Beaver activity in portions of this meadow area also have created high quality pools and lateral channel habitats.

Gully Creek

Gallatin National Forest fisheries staff surveyed Cub Creek (McClure 2000). They found that lower Gully Creek was a very stable B3 channel type that had high quality fish habitat. Woody debris was relatively common (55 pieces/1,000 ft.), and high quality pools were common. Spawning habitat was abundant.

Fish Abundance and Distribution

Main Cabin Creek

Only westslope cutthroat trout were captured in Cabin Creek. Genetic sampling indicated that this population was slightly hybridized with rainbow trout; however, the uppermost sample near Gully Creek may be pure and the lowermost sample near the trailhead contained Yellowstone cutthroat trout (Table 5). We captured sculpins up to the area near Forest Creek (mile 4.1), but did not capture any sculpins in the portion of the creek near the Middle Fork or above. These data suggest that the falls located near stream mile 2.0 either are a very recent phenomenon (< 100 years), or are not a barrier to fish movement. We are uncertain how sculpin and rainbow trout invaded the Cabin Creek drainage above this falls.

Relative catches of westslope cutthroat trout were fairly low for all sections of main Cabin Creek except for mile 4.1 in 1994 (where a short 65-foot section was sampled), and miles 2.7 and 5.8 in 1999 (Figure 13 and Appendix D). No population estimates were made for main Cabin Creek because relatively low densities of fish and large stream size made it difficult to obtain estimates.

Cub Creek

Gallatin National Forest fisheries staff surveyed Cub Creek (McClure 2000). They found that lower Cub Creek (up to mile 0.5) supported low densities of westslope cutthroat trout (6 fish per 1,000 feet of channel). No fish were found in upper Cub Creek near the crossing of Forest Service Trail 105. The falls found near stream mile 0.5 is probably a barrier to upstream movement of fish.

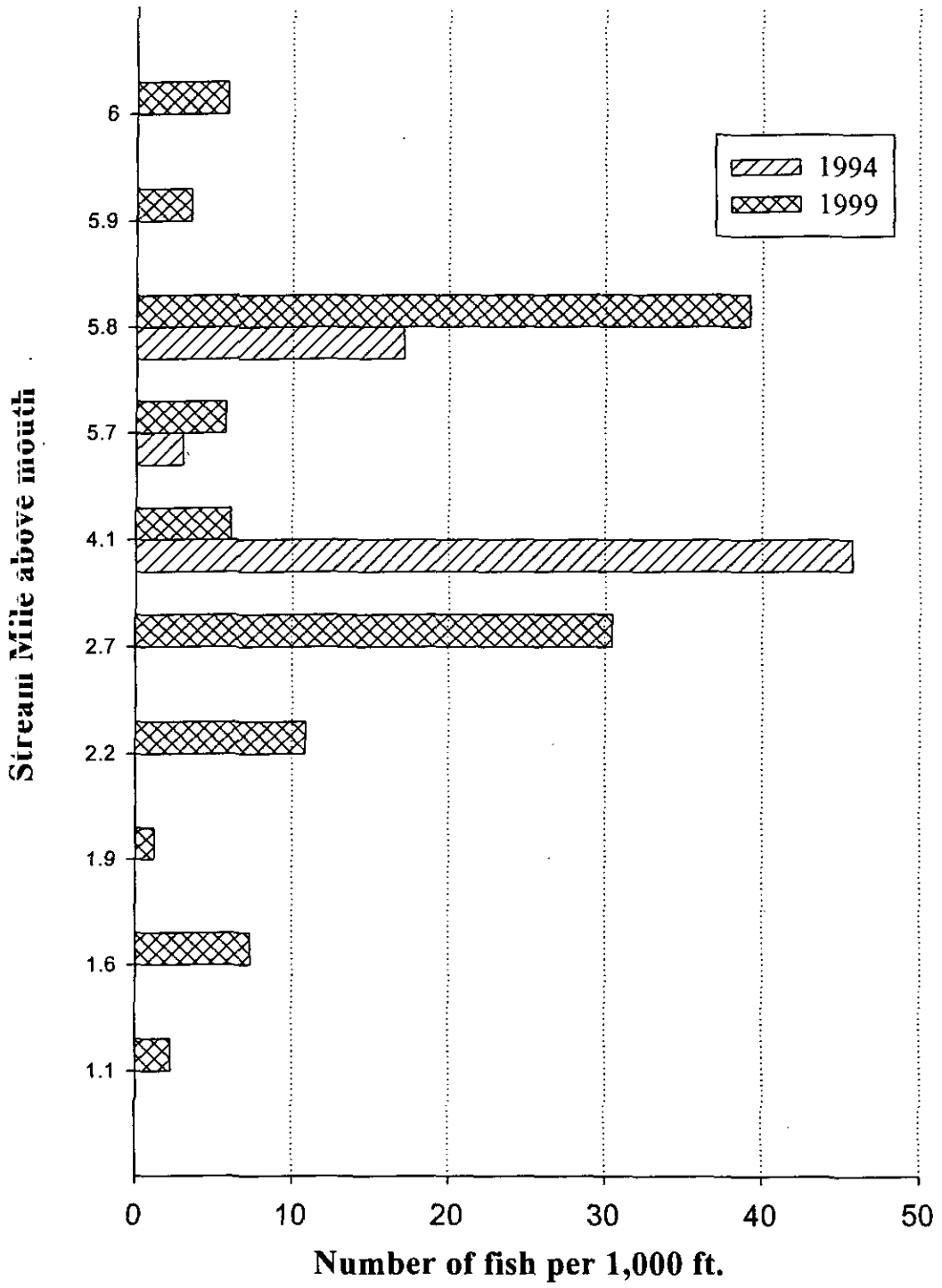

Figure 13. Catch of westslope cutthroat trout 3 inches and longer per 1,000 feet of stream length in sample sections of main Cabin Creek in 1994 and 1999.

Forest Creek

Gallatin National Forest fisheries staff surveyed Cub Creek (McClure 2000). They found no fish in a 2,000-foot sample section in the meadow portion of Forest Creek about 0.3 miles above its mouth.

Middle Fork Cabin Creek

Only westslope cutthroat trout were captured in the Middle Fork of Cabin Creek; however, genetic analyses for fish obtained from the Middle Fork in 1999 indicated these fish were also slightly hybridized, although the headwater area may still contain some pure westslope cutthroat trout (Table 5; letter of August 21, 2000 to Brad Shepard from Naohisa Kanda). Catches of westslope cutthroat trout were consistently higher in the middle portion of the Middle Fork (miles 1.6 to 2.7) than in the lower and upper portions (Figure 14 and Appendix D). Catches declined in several Middle Fork sample sections from 1994 to 1999. Anecdotal information suggests westslope cutthroat trout moved up into the upper reaches of Middle Fork Cabin Creek, (near the Forest Service cabin at mile 4.5) to spawn in June, even though this portion of the stream did not support fish during the summer. Most tributaries to the Middle Fork were sampled and many did not support fish, including the South Fork (Figure 15). However, catches of westslope cutthroat trout were moderately high in several tributaries (Figure 15). Distribution of westslope cutthroat trout in those small Middle Fork tributaries that supported fish did not extend very far up those streams.

Estimated numbers of westslope cutthroat trout 3 inches and longer ranged from 20 to over 170 per 1,000 feet of stream length in the Middle Fork (Figure 16 and Appendix F). In 1999 estimated numbers were slightly lower in all sections than in 1994 and 1995, except for the section at mile 4.3. Assuming an overall average of about 80 fish 3.0 inches and longer per 1,000 feet of stream length, the Middle Fork supports a total population of about 1,800 westslope cutthroat trout 3 inches and longer. Its tributaries probably support about another 200, so the overall population in the Middle Fork drainage is near 2,000.

South Fork Cabin Creek

No fish were captured in the South Fork Cabin Creek despite several attempts by us and by fisheries personnel from the Gallatin National Forest (McClure 2000). Spotted frogs were observed on most sampling occassions.

Gully Creek

Only one or two westslope cutthroat trout were captured in Gully Creek near its mouth on each of three sampling efforts.

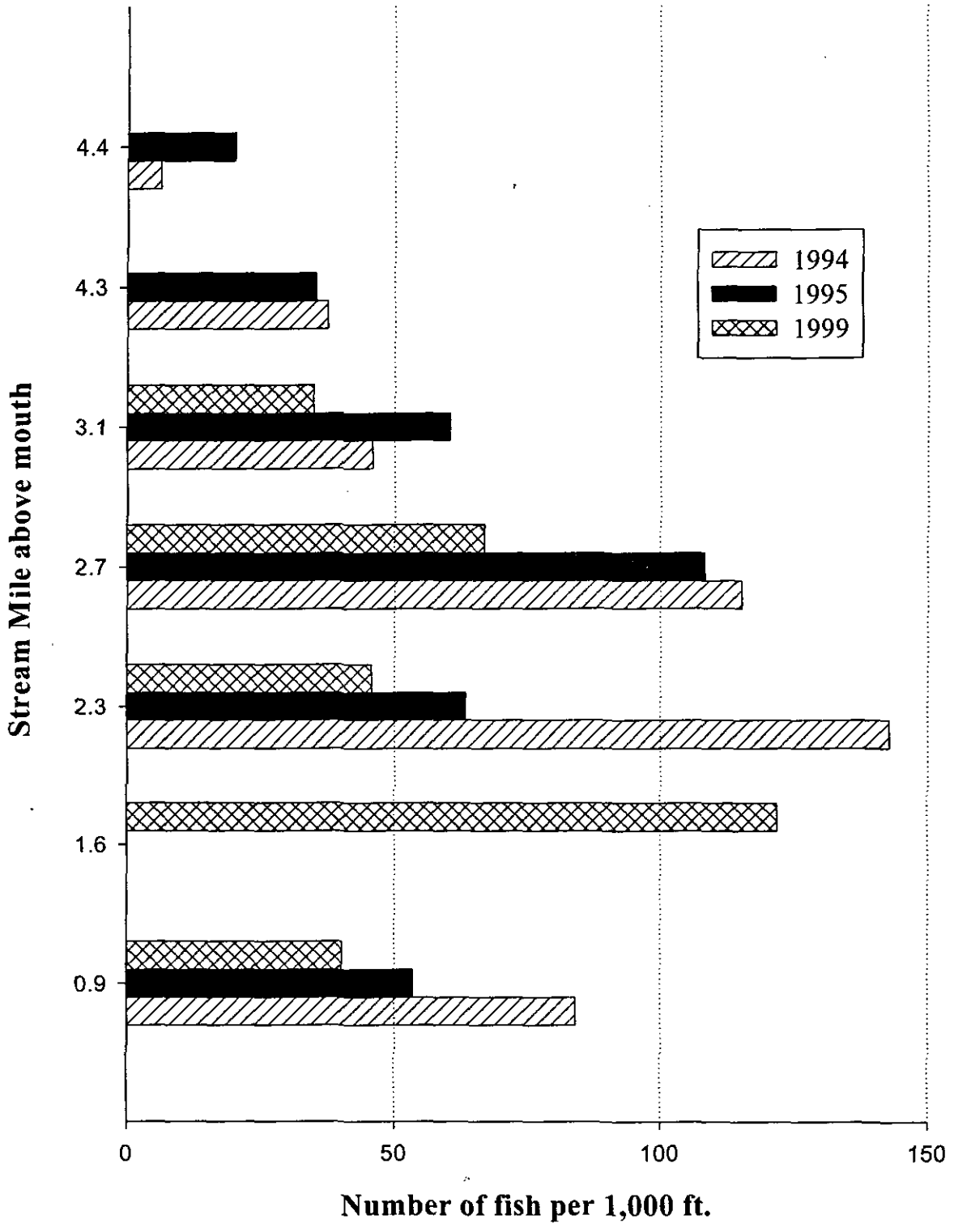

Figure 14. Catch of westslope cutthroat trout 3 inches and longer per 1,000 feet of stream length in sample sections of the Middle Fork Cabin Creek from 1994 to 1999.

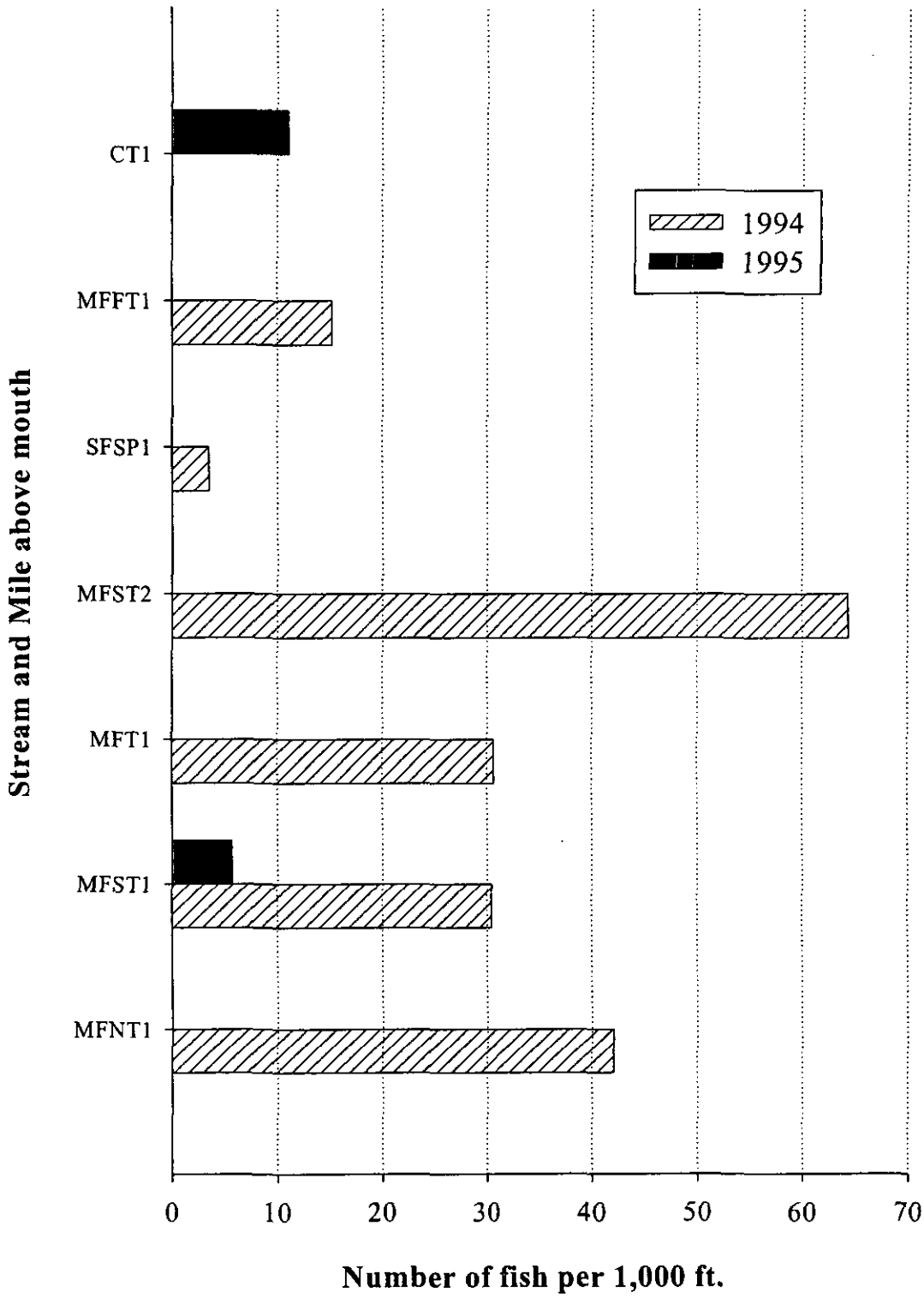

Figure 15. Catch of westslope cutthroat trout 3 inches and longer per 1,000 feet of stream length in sample sections of tributaries to the Middle Fork Cabin Creek from 1994 to 1999. See "Results" for abbreviations used to identify tributaries.

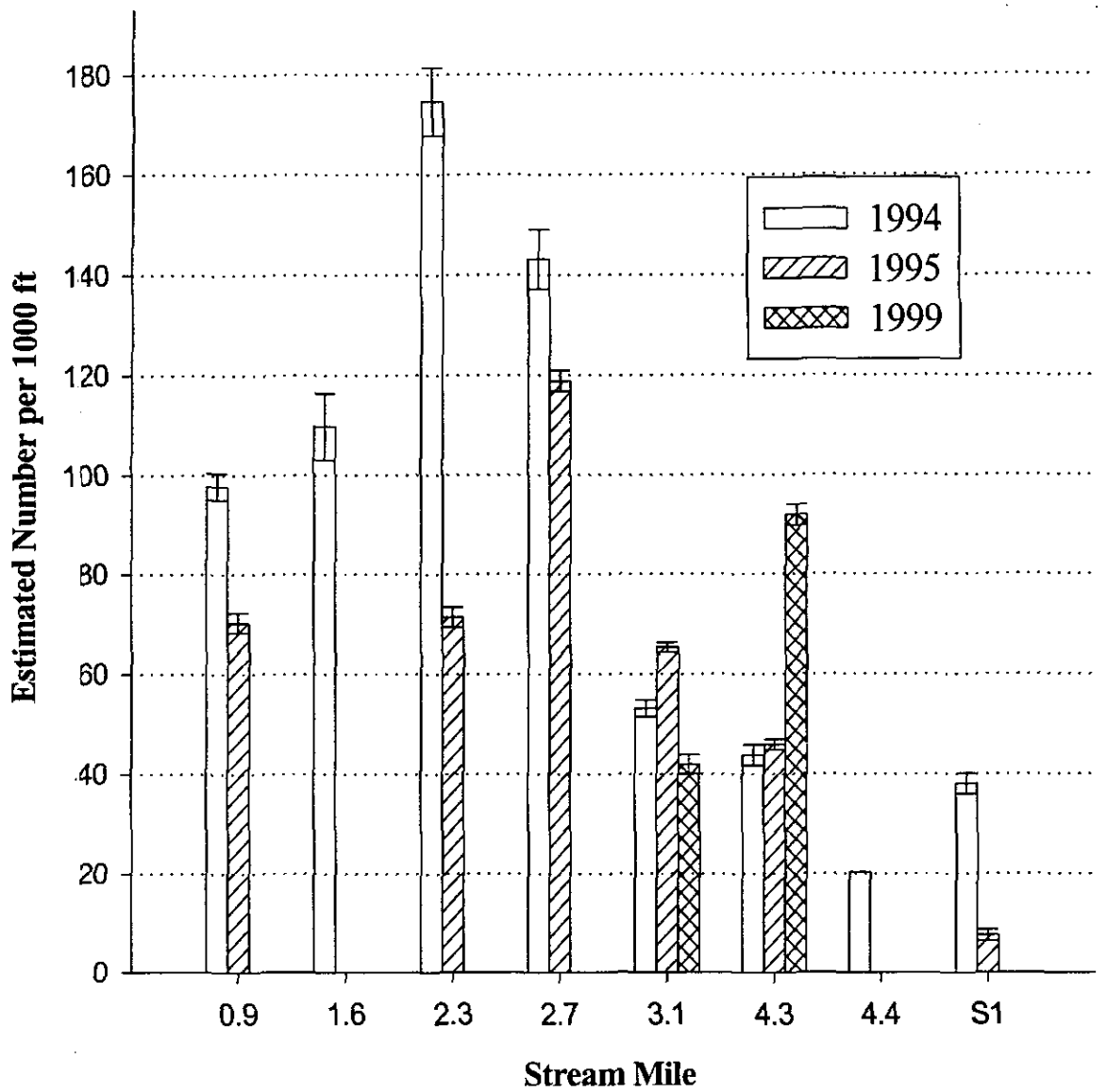

Figure 16. Estimated numbers of westslope cutthroat trout 3.0 inches and longer per 1,000 feet of stream length in seven sample sections (by stream mile) in the Middle Fork Cabin Creek and in the lower section of an unnamed tributary (S1) from 1994 to 1999. Vertical lines represent standard errors.

Fish Length and Weight

There was no clear trend in average size of fish throughout the sections in either main Cabin Creek or the Middle Fork Cabin Creek (Appendix F). Westslope cutthroat trout averaged from 6.0 to 10.0 inches long in all sections (where more than one fish was collected) of main Cabin Creek and around 6.0 inches in the Middle Fork sections. Length frequency histograms illustrated that fish were larger in main Cabin Creek (Figure 17). No clear age groups could be interpreted from length frequency histograms.

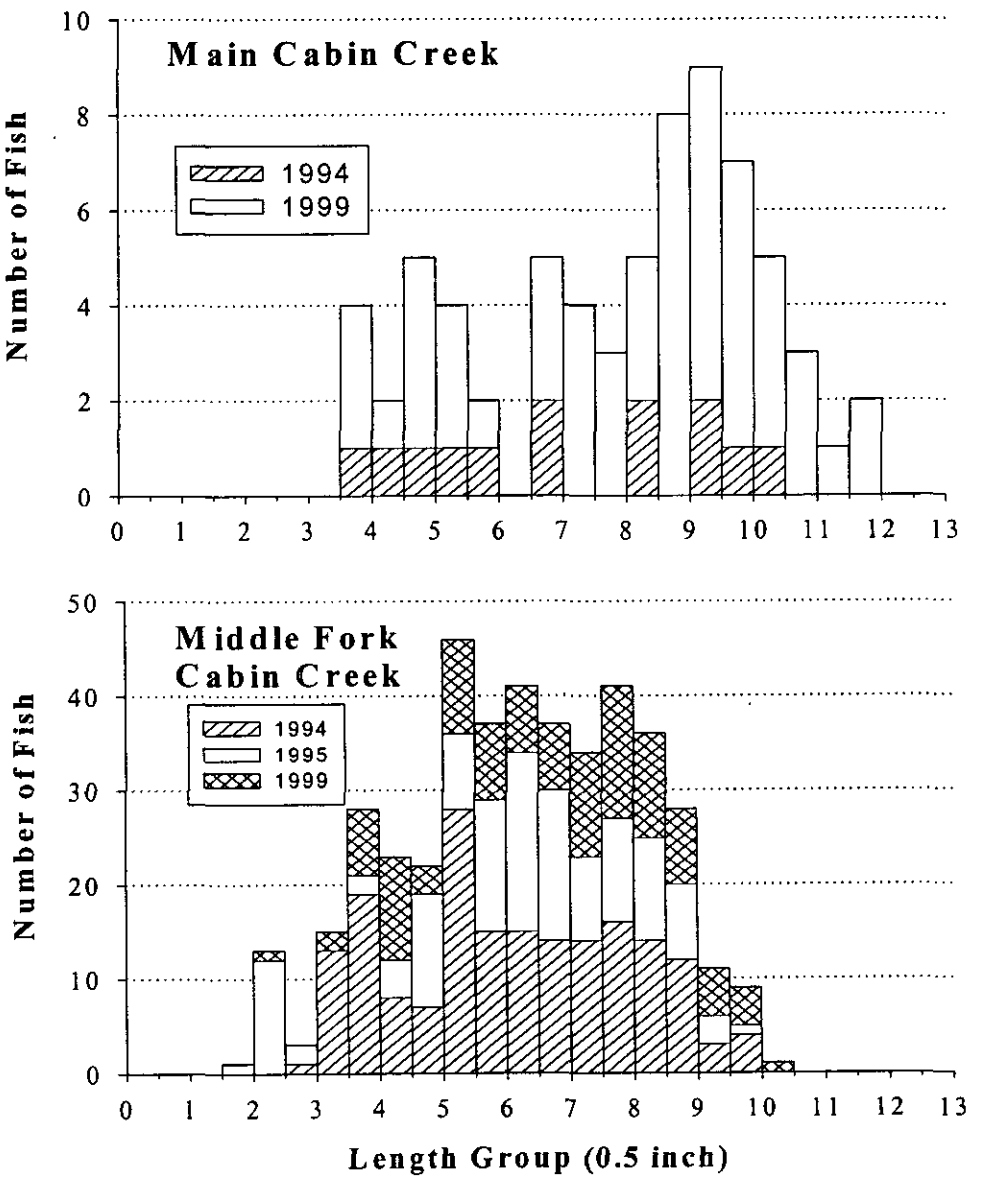

Figure 17. Length frequency histograms for westslope cutthroat trout in main Cabin Creek (top) and Middle Fork Cabin Creek (bottom) from 1994 to 1999.

Comparison to Previous Sampling

There was no record of previous sampling in Cabin Creek from the MRIS database, nor from catalogued reports.

Cherry Gulch

Cherry Gulch had no flow in its channel when checked in July of 1997 and July of 1998. The channel was observed both below and above the Forest Service boundary. A previous survey of Cherry Gulch also found the channel to be dry (Jim Brammer, Montana FWP, Dillon, MT, personal communication) and only documented a trickle of water near its headwaters.

Corral Creek

Corral Creek drains the Madison Range. The creek originates in the Lee Metcalf Wilderness Area, but most of its 9.5 stream miles flow through privately owned land. The upper reaches of Corral Creek flow through mixed conifer and aspen forest, while the lower 5.5 miles flow through open grassland. The only tributaries to Corral Creek are spring-fed streams that are too small to support resident fish populations. Near stream mile 5.5, a dam impounds the creek, creating a small pond. The landowner has altered a short section of stream above the pond to improve spawning habitat.

The Montana FWP fish planting database contains no records for Corral Creek.

Habitat

A 0.75 mile-long reach survey was conducted in Corral Creek beginning just above the pond. Of the three main habitat types (pool, riffle, run), riffle habitats dominated this reach (52%) and were made up of primarily high-gradient riffles. Pools, primarily in the form of plunge scour pools, were the next most abundant habitat type (40%)(Table 1).

A detailed habitat survey was conducted 6.0 miles above the mouth of Corral. At stream mile 6.0, the streambed was predominated by small and large gravels (Table 2). Woody debris was extremely abundant and much of this debris extended across the channel. Spawning habitat was also extremely abundant. Instream and bank cover, bank stability, and pool quality were all very high, and use of riparian habitats was low (Table 3). The average wetted width was 9.2 feet and the average water depth was 8.6 inches at this sample section.

Fish Distribution and Abundance

The landowner granted us permission to electrofish Corral Creek starting at stream mile 6.0, approximately 0.25 miles above the pond (Appendix D). A two-pass depletion estimate was made at this site. The 305 foot-long sample section supported an estimated 12 westslope cutthroat trout (SE: 4.5) 3 inches and longer (Appendix F). This translates into an estimated 39.3 westslope cutthroat trout per 1000 feet of stream length. No fish were captured at stream mile 6.5. It appeared that low flows limited the upstream distribution of fish at some point below this sample section.

The landowner reported that rainbow trout occupy the stream below the pond, and that only westslope cutthroat trout are present above the impoundment. However, based on our observations the dam does not present a total barrier to upstream fish movement. Some of the captured westslope cutthroat appeared to have been slightly introgressed (hybridized) with rainbow trout based on external morphometric examination. Fin clips were taken from 21 fish for genetic analysis during 1998 sampling. DNA analyses through PINE markers of these fin clips revealed that the westslope cutthroat trout made up about 86% of the markers (letter to Brad Shepard from Naohisa Kanda dated November 8, 1999) (Table 5). Genetic material from both rainbow trout (8%) and Yellowstone cutthroat trout (6%) were also found.

Fish Length and Weight

Westslope cutthroat trout ranged from 2.1 to 7.9 inches in length, with an average length of 4.4 inches (Figure 18 and Appendix G). Relatively large trout (> 12 inches), presumably westslope cutthroat trout, were observed in the pond but were not collected.

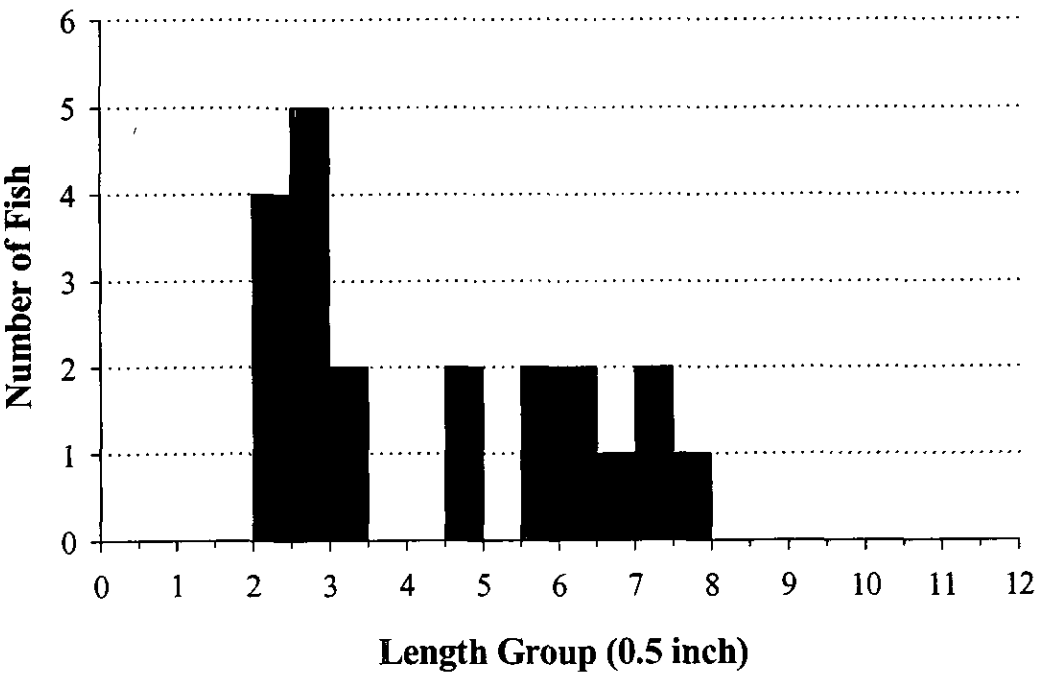

Figure 18. Length frequency histogram for westslope cutthroat trout captured in Corral Creek during 1998.

Comparisons to Previous Sampling

There were no records of previous sampling in Corral Creek from the MRIS database, or from catalogued reports.

English George Creek

English George Creek drains the Gravelly Range and enters the Madison River from the west. Its upper reaches flow through the Beaverhead-Deerlodge National Forest while its lower reaches lie within Montana Fish, Wildlife and Parks' Wall Creek Wildlife Management Area (Figure 1). English George Creek has one major tributary, the South Fork of English George Creek, which enters main English George Creek approximately 0.8 miles above its mouth. English George Creek is approximately 3.4 miles in length and the South Fork is also approximately 3.4 miles long. Both main English George Creek and the South Fork flow through moderately steep forested lands in their upper reaches before flowing out through a transitional zone with mixed coniferous and deciduous trees and moderate gradients. Both streams then flow through a lower gradient meadow area. Main English George Creek flows over an approximately six-foot waterfall at about mile 0.6, about 0.2 mile below the mouth of the South Fork. This waterfall is created by a shelf of conglomerate rock and is presently a barrier to upstream fish movement (Figure 4). The Montana FWP fish-planting database indicated no fish have been planted into the English George Creek drainage.

Habitat

An Optic Stowaway® thermograph was placed in English George Creek near the mouth of the South Fork from June 25 to October 7, 1997 (Figure 3). During the summer average daily temperatures generally ranged from 50 to 60°F, however, maximum daily temperatures approached and exceeded 70°F on several occasions (Figure 19). In 1999 three thermographs were placed in main English George Creek and two were placed in the South Fork. Temperatures in the lower portions of main English George and the South Fork rose to over 75°F, however, temperatures in the upper portions of both creeks did not rise higher than 55°F (Figure 20).

English George Creek

A reach survey was conducted in English George Creek from its mouth at the Madison River upstream about 1,000 feet. The lower portion of the creek was dominated by riffle and run habitats (Table 1).

A detailed habitat survey was conducted at mile 2.7 in English George Creek. Very large (boulders and cobble) and very small (sand and silt) particles dominated the streambed in this survey section (Table 2). Woody debris was abundant and spawning habitat was limited, but probably adequate. Instream and bank cover and bank stability were high, pool quality was moderate, and use of riparian habitats was low (Table 3). Pools and step pools were the most abundant of the main habitat types, followed by runs and then riffles (Table 4). This section was in a relatively high gradient portion of the stream, so high gradient habitat sub-types such as cascade and high gradient riffles dominated riffle types, step and dammed pools dominated pool types, and there were several step run sub-types. Average depth in the section was 3.6 inches, but the average depth of pool types was deeper (Table 4).

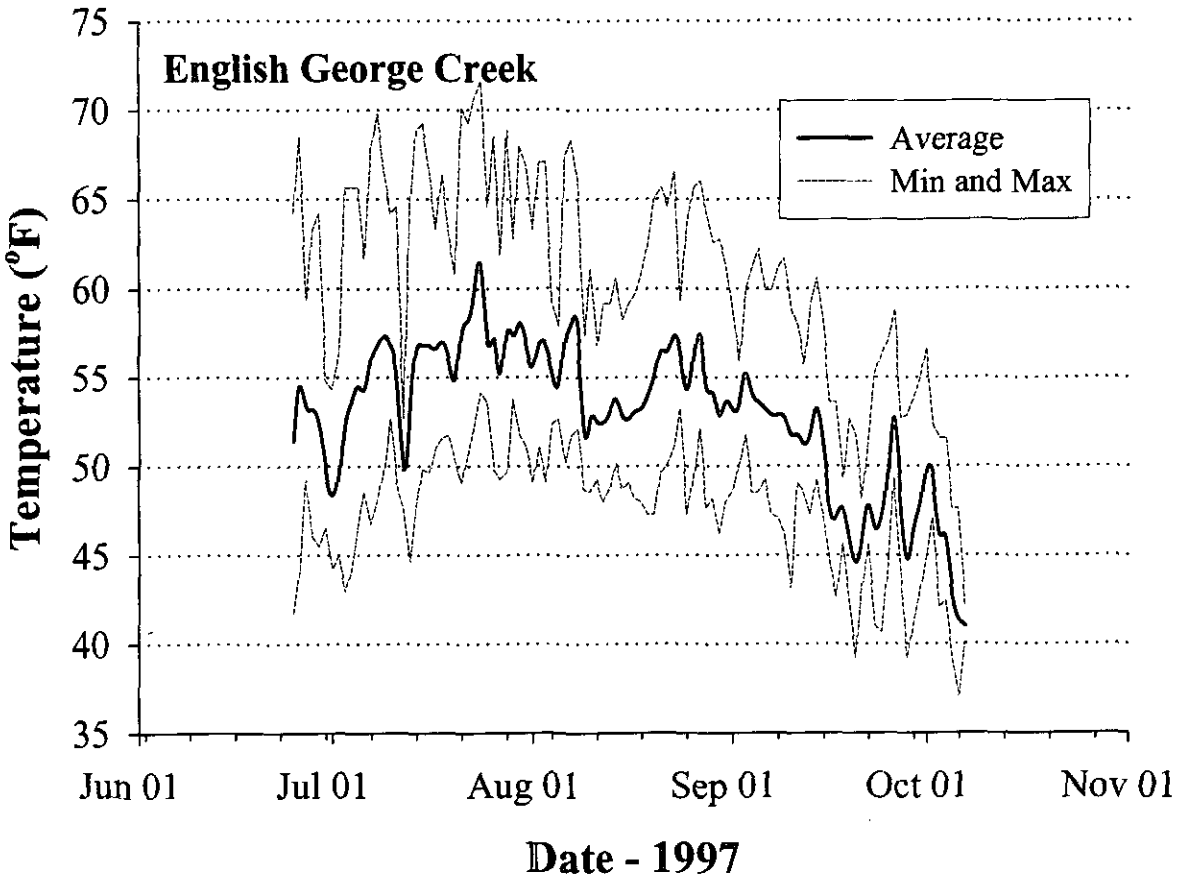

Figure 19. Average, minimum, and maximum daily water temperatures in English George Creek below the Wall Creek Road during the summer 1997.

South Fork English George Creek

A detailed habitat survey was conducted at mile 1.5 in the South Fork of English George Creek. Riffle habitat types dominated the sample section, comprising over 70% of the length of the section (Table 4). Average depth of the section was 4 inches and the average pool volume and residual pool volume were relatively low (Table 4). Gravel-sized particles dominated the streambed, woody debris was scarce, but spawning gravels were abundant (Table 2). Ratings of instream and bank cover, bank stability, pool quality, and use of riparian habitats were all moderate (Table 3). It appeared that historic livestock grazing had impacted the stream channel, but it was recovering at the time of this survey.

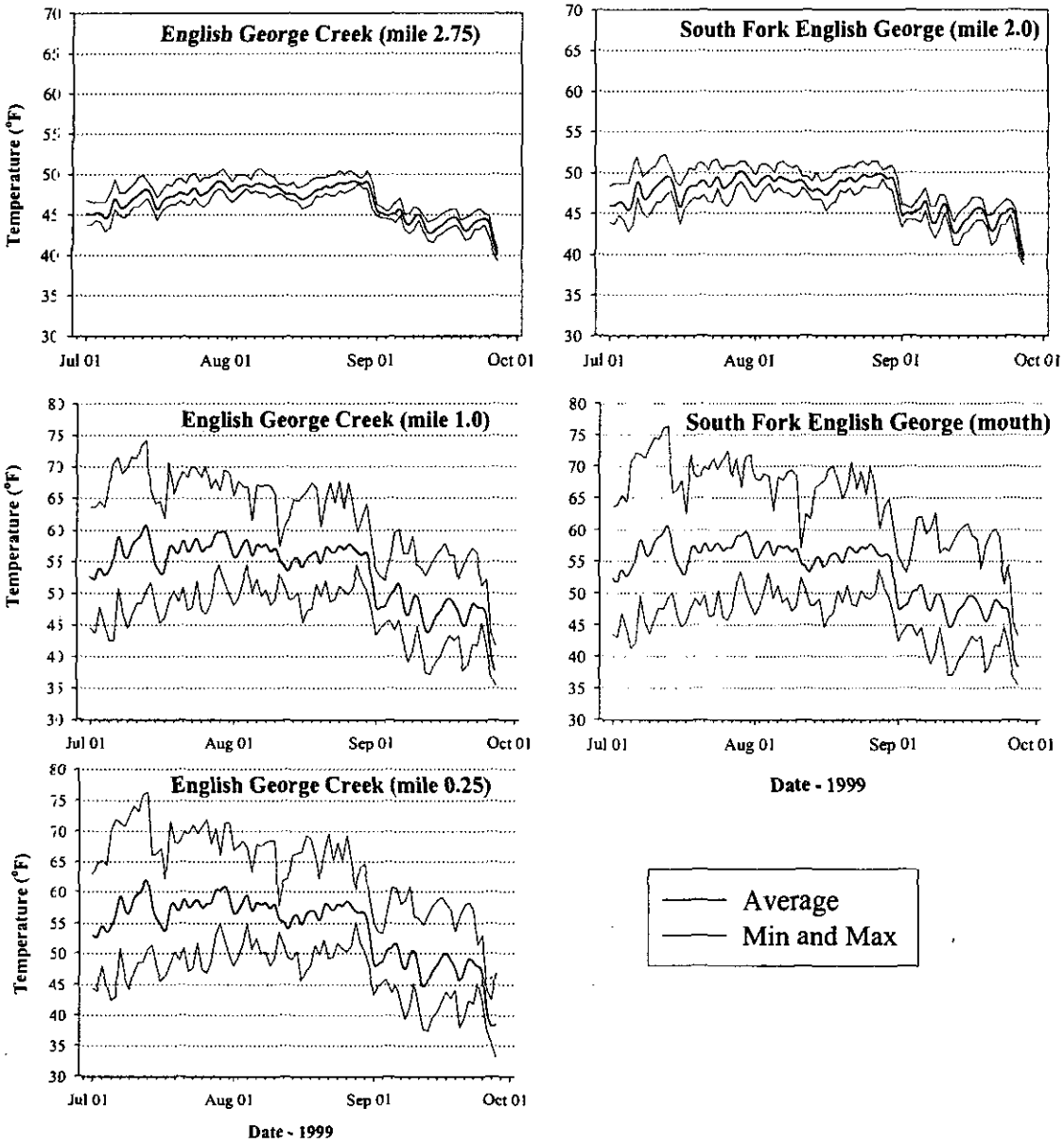

Figure 20. Average, minimum, and maximum daily water temperatures at three locations in English George Creek and two locations in the South Fork English George Creek during the summer 1999.

Fish Distribution and Abundance

English George Creek

Brown and rainbow trout were found in the lower portion of English George Creek, below the barrier at mile 0.6, while westslope cutthroat trout were found in all sections above this barrier where fish were captured (Figure 21; Appendix D). A 15 fish sample of westslope cutthroat trout collected on August 1, 1992 were found to be slightly introgressed with rainbow trout (95% westslope cutthroat trout and 5% rainbow trout; Montana Resource Information System database) (Table 5). Additional fish were collected from throughout the drainage in 1999 to validate the genetic status of this population. Westslope cutthroat trout were rare or absent from the lower portions of English George Creek (miles 0.7 to 2.0). The low abundance might be related to high water temperatures documented in this portion of the drainage (Figures 20). Relative abundance of westslope cutthroat trout increased in an upstream direction up to about mile 2.7, then declined. Relative abundances were higher in sections re-sampled in English George Creek in 1999 (Appendix D). No fish barriers were found in English George Creek above stream mile 0.6, but stream flows above mile 3.0 were so low that it was considered marginal for fish.

Depletion population estimates were made in English George Creek at mile 0.5 and 2.7. A 351 foot-long section at mile 0.5 of English George Creek supported an estimated 6 (SE: 0.5) brown trout 3 inches and longer which translates to about 17 per 1,000 feet of stream length (Appendix F and Figure 22). A 338 foot-long section at mile 2.7 of English George Creek supported an estimated 36 (SE: 1.8) westslope cutthroat trout 3.0 inches and longer which translates to about 107 per 1,000 feet of stream length.

South Fork English George Creek

Westslope cutthroat trout were rare or absent from the lower portions of the South Fork (miles 0 to 1.0). Relative abundances were lower in sections of the South Fork re-sampled in 1999 (Appendix D). A barrier to upstream fish movement was found in the South Fork at about mile 3.2. A depletion population estimate was made in the South Fork at mile 1.5. A 328 foot-long section in the South Fork at mile 1.5 supported an estimated 16 westslope cutthroat trout 3.0 inches and longer (SE: 0.6) or about 49 per 1,000 feet of stream length.

Fish Length and Weight

Brown trout in lower English George Creek averaged 5.1 inches (range 4.2 – 6.0) and the only rainbow trout captured was 5.7 inches long (Appendix F). Westslope cutthroat trout in main English George Creek were generally smaller than in the South Fork and average sizes were similar in 1997 and 1999 (Appendix F and Figure 23). Most of the smaller (< 3 inch) westslope cutthroat trout captured were captured above mile 2.5 in main English George Creek .

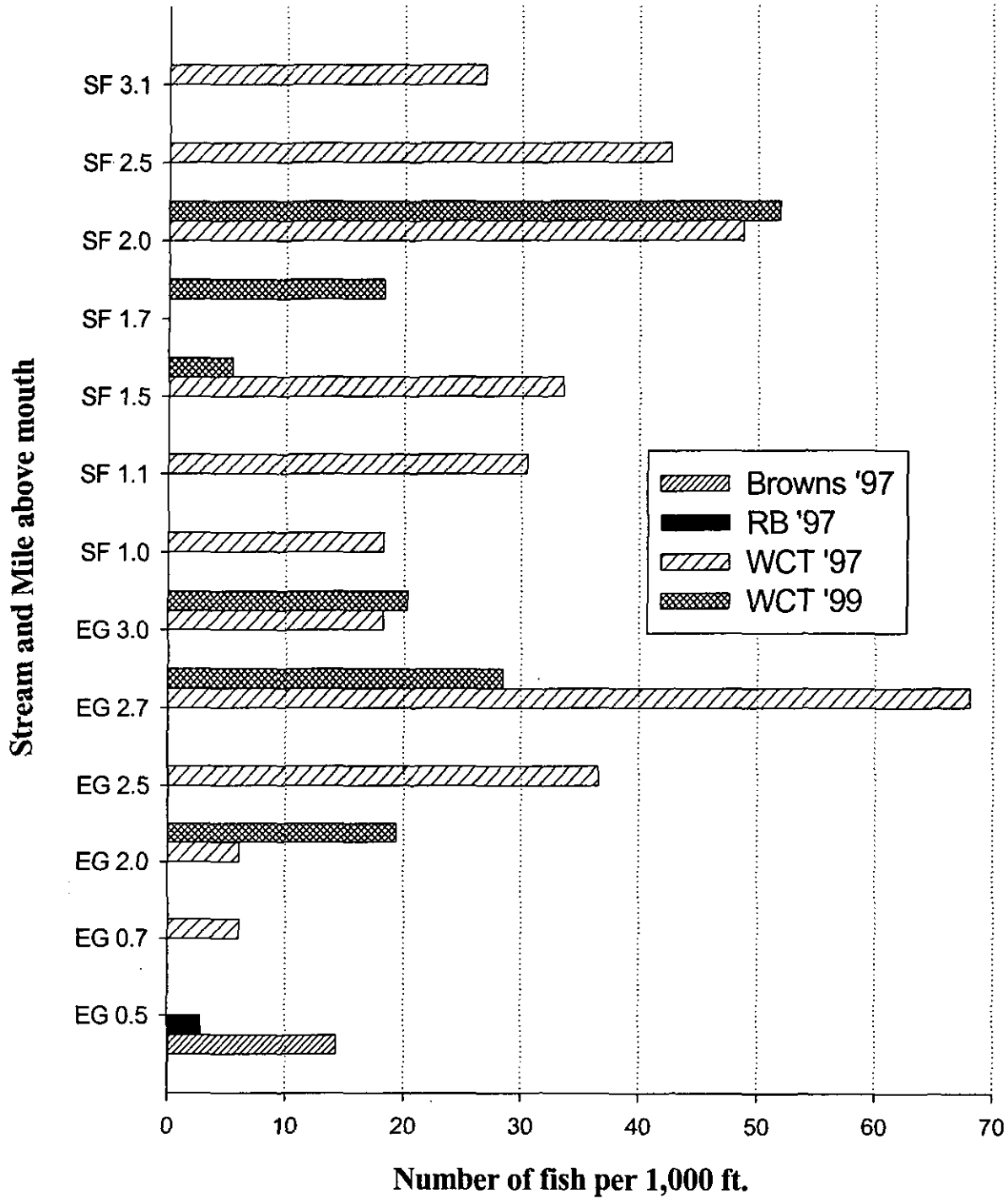

Figure 21. Catch of brown, rainbow (RB), and westslope cutthroat trout (WCT) 3.0 inches and longer in main English George Creek (EG and stream mile) and the South Fork English George Creek (SF and stream mile) during 1997 and 1999.

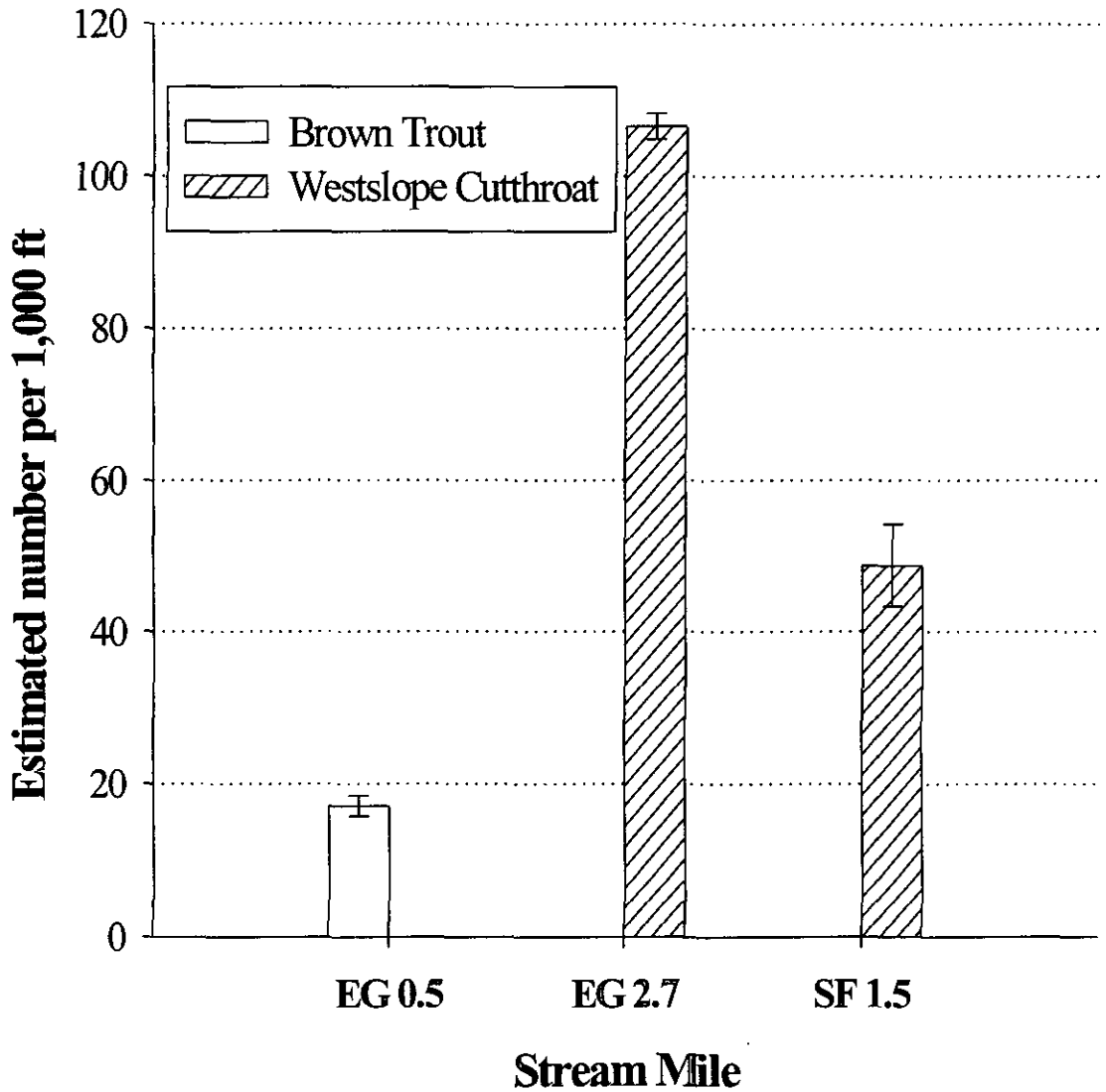

Figure 22. Estimated number of brown and westslope cutthroat trout 3.0 inches and longer in English George (EG) and the South Fork English George (SF) creeks by stream mile. Vertical lines represent standard errors.

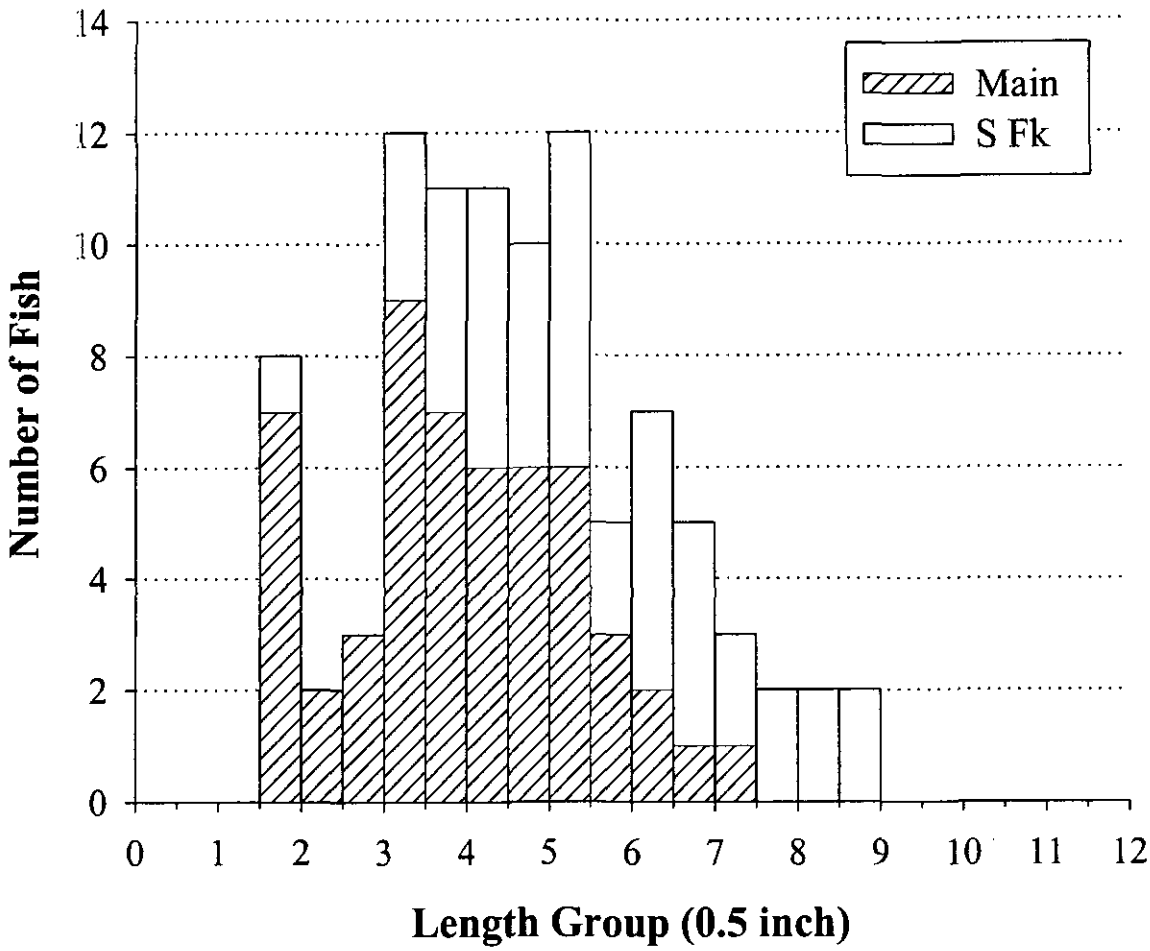

Figure 23. Length frequency histogram for westslope cutthroat trout captured in English George Creek and the South Fork English George Creek during the summer of 1997.

Comparison to Previous Sampling

Previous sampling in the English George Creek drainage in 1995 found similar distributions of westslope cutthroat trout (J. Brammer, Montana FWP, Dillon, MT, files). However, in October of 1995 Brammer reported capturing 28 westslope cutthroat trout in the lower South Fork (about mile 0.4), while sampling by Brammer's crew in late-June and early-July of 1995 and our sampling during this same time period in 1997 found very few fish in the South Fork up to about mile 1.0. It may be that westslope cutthroat trout in the South Fork move downstream during the fall to overwinter in the lower portion of the stream. Similar to our work, Brammer's crew found little to no use of main English George Creek from the falls at mile 0.6 up to about mile 2.0. The highest densities of westslope cutthroat trout were found from mile 2.0 to 3.0.

Horse Creek

Horse Creek drains the Gravelly Range and enters the Madison River from the west. Horse Creek is approximately 13 miles in length. It originates in a small, unnamed pond near Monument Ridge and its upper 10.3 miles flows through the Beaverhead-Deerlodge National Forest, while its lower 2.7 miles flow through private property (Figure 1). Horse Creek has four major named tributaries. Tepee Creek is about 2.5 miles in length and enters main Horse Creek from the north approximately 10.3 miles above its mouth. Alpine Creek is also about 2.5 miles long and enters main Horse Creek from the southwest approximately 9.5 miles from its mouth. Deer Creek is about two miles long and enters Horse Creek from the south approximately 8.5 miles from its mouth. Camp Creek is about 1.5 miles long and enters Horse Creek from the south approximately 5.5 miles from its mouth. Tepee, Alpine, Deer, and Camp creeks and the upper 4.5 miles of Horse Creek all flow through relatively steep and narrow V-shaped valleys with coniferous forest bordering the stream. Two 0.5 mile-long segments of Horse Creek meander through open meadows at stream mile 9.5 and 6.5. An approximately 10 foot-high waterfall was located at stream mile 7.5 in Horse Creek. This waterfall is believed to be a total barrier to upstream movement of fish (Figure 4). From mile 8.5 down to mile 2.7 (at the Forest Service boundary) Horse Creek flows through moderately confined valley bottoms with willow, grasses and sedges bordering the channel interspersed with steep, cascade reaches bordered by coniferous forest. After leaving Forest Service lands Horse Creek flows through sagebrush and grass terraces that are forested with conifers on the north-facing slopes.

The Montana FWP fish planting database indicated that 20,400 undesignated cutthroat trout were planted into Horse Creek in 1931, 13,200 two inch-long rainbow trout fry were planted in 1948 and 10,000 rainbow trout fry (1 inch) were planted in 1951 (Appendix G). No other records of fish planting in streams of the Horse Creek drainage were found.

Habitat

An Optic Stowaway® thermograph was placed in Horse Creek near the Forest Service boundary from June 20 to October 28, 1998. During 1998 the summer daily temperatures generally averaged around 50°F, with maximum daily temperatures never going above 58°F (Figure 24). Five thermographs were placed in main Horse Creek from July 1 to September 19, 1999. These thermographs were located just above Horse Creek's mouth and 2.5, 5.5, 8.5, and 10.5 miles above the mouth. Water temperatures were relatively cold throughout the Horse Creek drainage with maximum summer temperatures never exceeding 60°F and average daily temperatures ranging from 45 to 50°F (Figure 25). During 1999 thermographs were placed in both Tepee and Alpine creeks above their mouths from July 1 to September 19. In Alpine Creek the maximum summer temperature was about 46°F and the average temperatures were near 40°F (Figure 26). In Tepee Creek the maximum summer temperature was about 55°F and the average summer temperature was under 50°F (Figure 26).

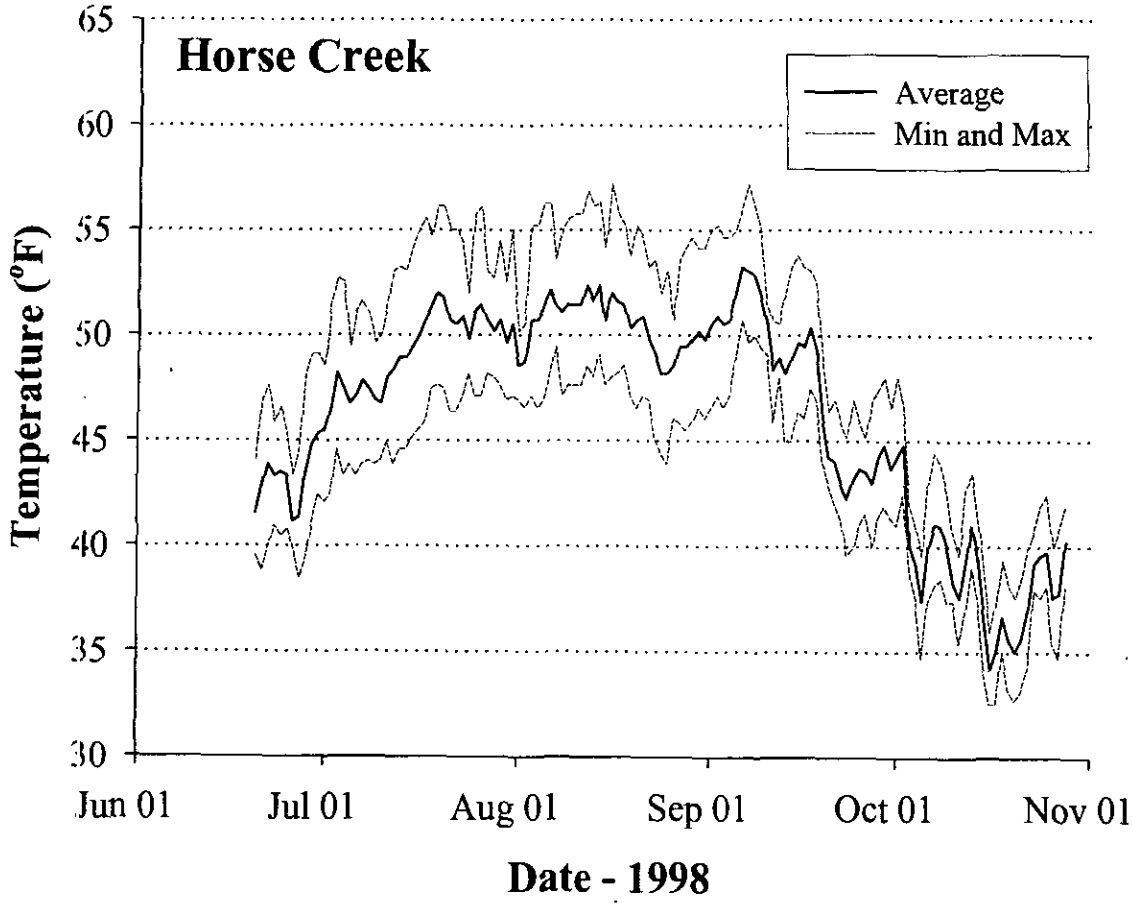

Figure 24. Average, minimum, and maximum daily water temperatures in Horse Creek near the Forest Service boundary during the summer of 1998.

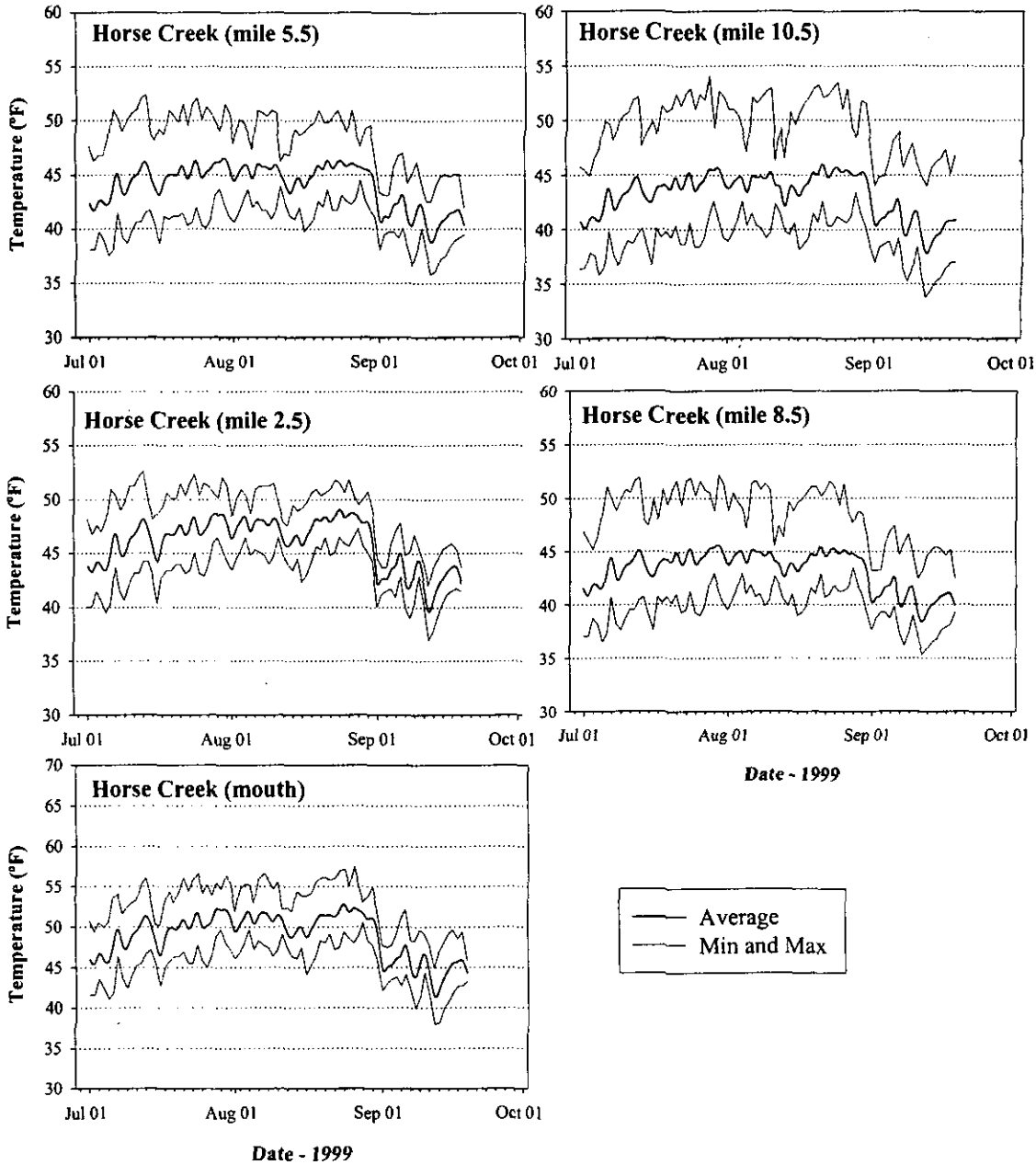

Figure 25. Average, minimum, and maximum daily water temperatures at five locations in Horse Creek during the summer of 1999.

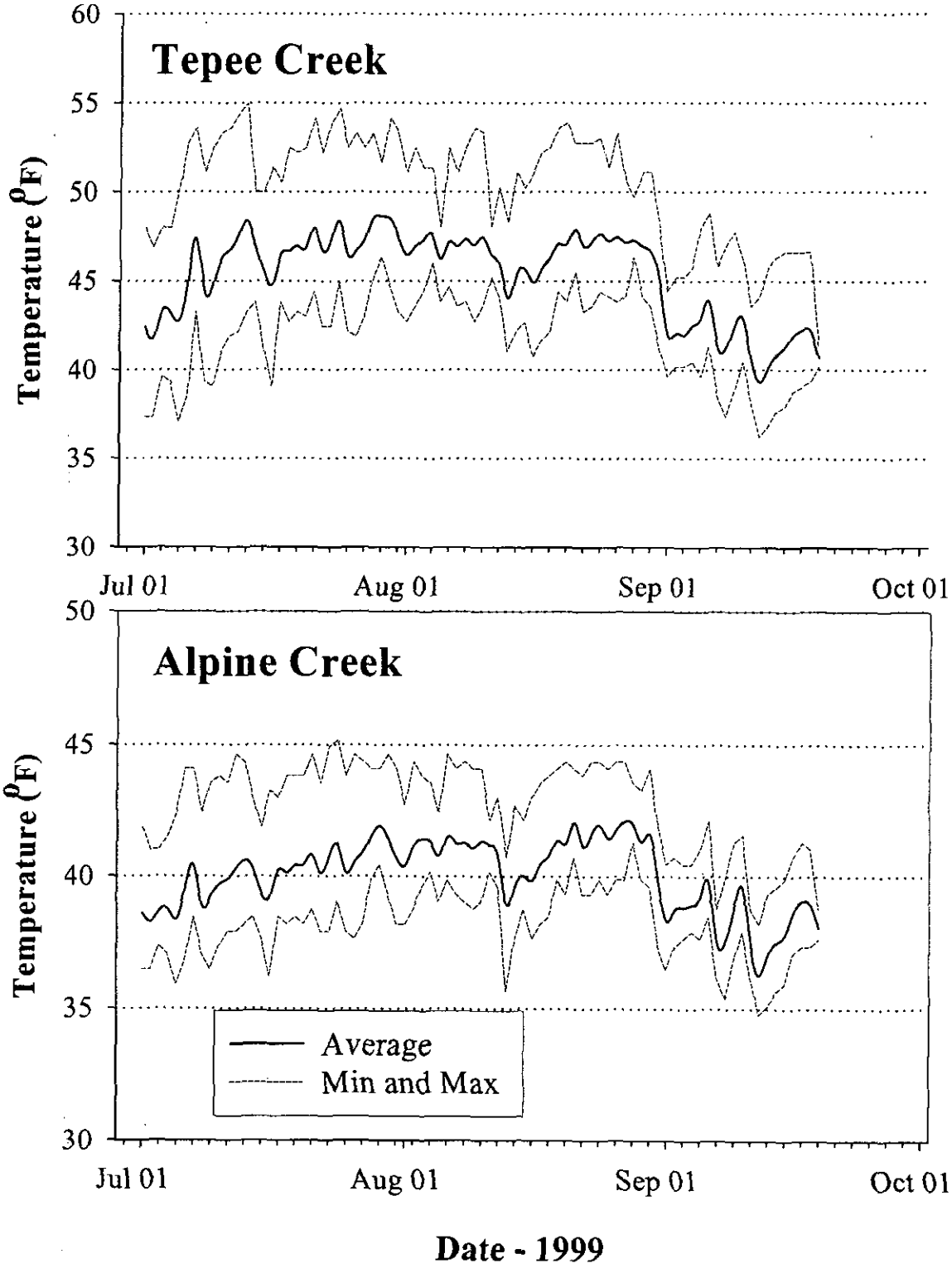

Figure 26. Average, minimum, and maximum daily water temperatures near the mouths of Tepee and Alpine creeks, tributaries to Horse Creek, during the summer of 1999.

Horse Creek

A half-mile reach survey was conducted in Horse Creek between stream miles 9.5 and 10.0 in the low gradient meandering meadow reach. The three main habitat types (pool, riffle, and run) were found in nearly equal numbers through this reach (Table 1). Low gradient riffles dominated riffle types, while later scour pools dominated pool types. A half-mile reach survey was also conducted in Tepee Creek from mile 0.5 to 1.0. This was a relatively high gradient reach and pools dominated the main types (53%) and were made up primarily of plunge scour pools. Riffles were the next most abundant (38%) and low and high gradient riffles were seen in nearly equal numbers.

Detailed habitat surveys were conducted at miles 5.5, 7.0, 8.0, 8.5, 9.5 and 10.0 in Horse Creek (Tables 2, 3, and 4). In Horse Creek the streambed was dominated by large gravels at stream miles 5.5 and 9.5 and by cobble in the other sections. Small gravel was prevalent in lowermost (mile 5.5) and upper two sections (miles 9.5 and 10.0). Small woody debris was relatively abundant in the lowermost and uppermost sections, absent at stream mile 9.5, and common in the other three sections. Large woody debris was common at all locations sampled, except for mile 9.5 where it was absent. Little of the small debris crossed the stream channel, but about 20-30% of the large woody debris spanned the channel. Spawning habitat was relatively abundant in all sampled sections, except at mile 8.5. Pool habitats made up about 30% of the channel length at stream miles 5.5 and 8.5; less than 20% at miles 7.0, 8.0, and 10.0; and less than 10% at mile 9.5. Average wetted widths ranged from 17.2 to 7.4 feet and average water depths ranged from 16.6 to 8.9 inches.

Tepee Creek

Detailed habitat surveys were conducted at miles 0.1 and 1.0 in Tepee Creek (Tables 2, 3, and 4). Cobbles and large gravels made up a high proportion of the streambed at the lowermost section (mile 0.1), but silt-sized material dominated the streambed in the upper section (mile 1.0). Woody debris was relatively abundant in the lower section, while small debris was common and large debris was absent from the channel in the upper section. Spawning habitat was very abundant near the mouth, but absent in the upper portion of the channel due to the high proportion of silt in the streambed. Pool habitats made up less than 25% of the sample section's length near the mouth of Tepee Creek. The average width was 6.6 feet and the average depth was 7.8 inches.

Fish Distribution and Abundance

Horse Creek

A single brown trout was found at stream mile 2.5 in Horse Creek, all other fish captured were westslope cutthroat trout (Figure 27 and Appendix D). Some of the captured westslope cutthroat trout at stream mile 2.5 and 3.0 appeared to have been slightly introgressed (hybridized) with rainbow trout based on external morphometric examination. Fin clips were taken for genetic analyses during 1998 sampling at several locations throughout Horse Creek. DNA analyses

through PINE markers of these fin clips revealed that the westslope cutthroat trout made up about 88% of the markers below the waterfall at about stream mile 7.5 and about 98% of the

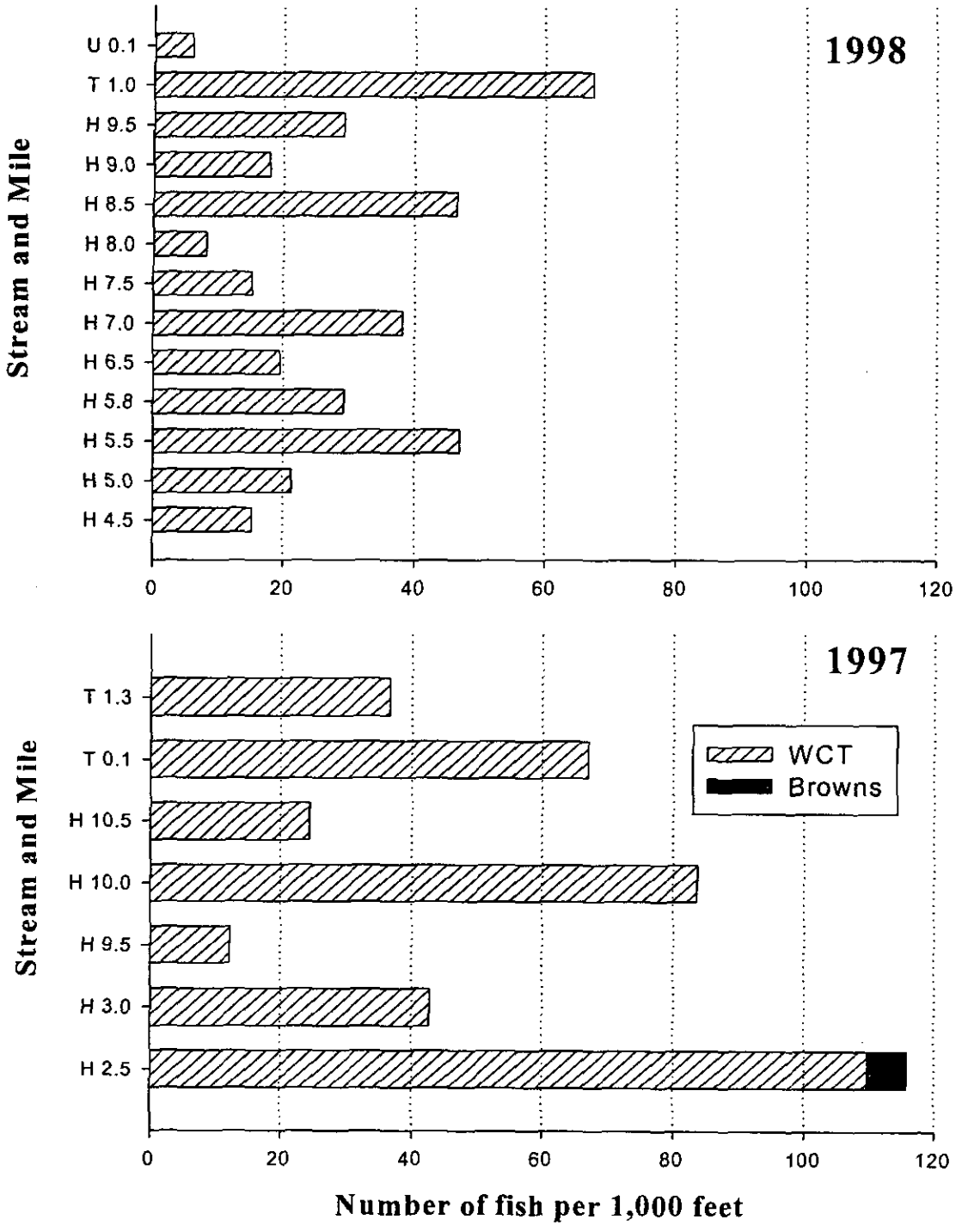

Figure 27. Catch of westslope cutthroat trout (WCT) and brown trout 3.0 inches and longer per 1,000 feet of stream length in Horse (H and stream mile), Tepee (T and stream mile), and an unnamed tributary (U and stream mile) during 1997 (bottom) and 1998 (top).

markers above the waterfall (Table 5). Genetic material from both rainbow trout (3%) and Yellowstone cutthroat trout (9%) were found below the falls, while only material from Yellowstone cutthroat trout (2%) were found above the falls.

The relative abundance of westslope cutthroat trout (expressed as number of fish per 1,000 feet of stream length captured in the first electrofishing pass) in Horse Creek was highest at stream mile 2.5, gradually dropped from mile 4.5 to 8.0 and then was inconsistent between miles 8.5 to 10.5 (Figure ??). However, electrofishing was difficult in Horse Creek in the moderately high gradient sample section at stream mile 5.0. No fish were captured in Horse Creek at stream mile 11.0 where the channel was extremely small. Flows in this area were believed to be intermittent during low water years.

Depletion population estimates were made in Horse Creek at stream miles 5.5, 7.0, 7.5, 8.0, 8.5, 9.5 and 10.0 and in Tepee Creek at stream mile 0.1. Only westslope cutthroat trout were captured in these sections. Estimated numbers per 1,000 feet were highest at stream miles 5.5, 8.5 and 10.0 in Horse Creek and at stream mile 0.1 in Tepee Creek (Figure 28 and Appendix E). It appeared that the waterfall barrier in Horse Creek located near stream mile 7.5 influenced abundance of fish as the two sample sections immediately above the falls (miles 7.5 and 8.0) had the lowest estimated densities.

Tepee Creek

Relative abundance estimates in lower Tepee Creek (stream mile 0.1 to 1.3) were moderately high. A barrier to upstream fish passage was located in Tepee Creek at about stream mile 1.5 and no fish were captured immediately above this barrier.

Alpine, Deer, Camp and unnamed creeks

No fish were observed or captured in Alpine, Deer, or Camp creeks. Equipment malfunction limited sampling in Deer Creek, but it likely does not support fish. One cutthroat trout was found in the lower segment of one unnamed tributary that entered upper Horse Creek from the north.

Fish Length and Weight

The single brown trout captured in lower Horse Creek was 10 inches in length. Westslope cutthroat trout captured in the Horse Creek drainage ranged from 1.7 to 12.6 inches (Appendix F and Figure 29). Most of the smaller (< 3.5 inch) westslope cutthroat trout captured in the drainage were captured above mile 5.5 and the majority of these were captured above the waterfall at stream mile 7.5. The lower portion of Horse Creek (stream mile 2.5 to 5.0) supported fish from 5 to 11.5 inches long.

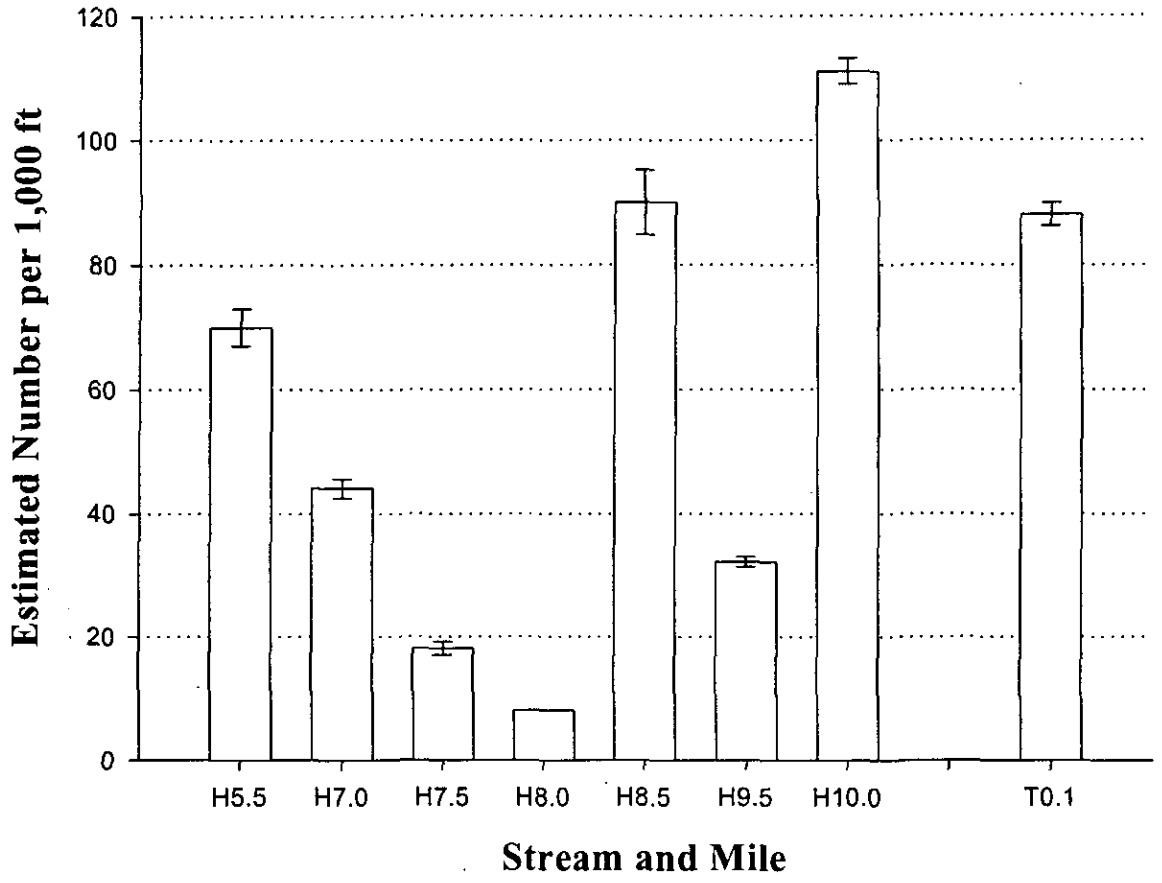

Figure 28. Estimated number of westslope cutthroat trout 3.0 inches and longer per 1,000 feet of stream length in Horse Creek (H and stream mile) and Tepee Creek (T and stream mile) along with standard errors (vertical lines).

Comparison to Previous Sampling

Horse Creek and its tributaries were surveyed for habitat condition within Forest Service lands (Jim Brammer, Montana FWP, Dillon, files). Horse Creek was stratified into five reaches within the Forest. The first extended from the Forest Service boundary upstream about 2.75 miles to Camp Creek and was found to contain excellent fish habitat. The second reach extended from Camp Creek up to Deer Creek and also was found to contain excellent fish habitat. The third reach went from Deer Creek up to the lower boundary of the meadow starting below Alpine Creek and was a steep cascading reach with good habitat. The fourth reach encompassed the meadow near Alpine Creek and this reach was found to be less suitable with natural sloughing banks and higher levels of fine sediments in the channel. The fifth reach extended from the head of the meadow up to the headwaters of Horse Creek and suitable, but marginal, habitat was only found in the lower 0.25 mile of this reach. They observed fish throughout Horse Creek, except until they were more than 0.25 mile above the meadow. This result is similar to our sampling for distribution.

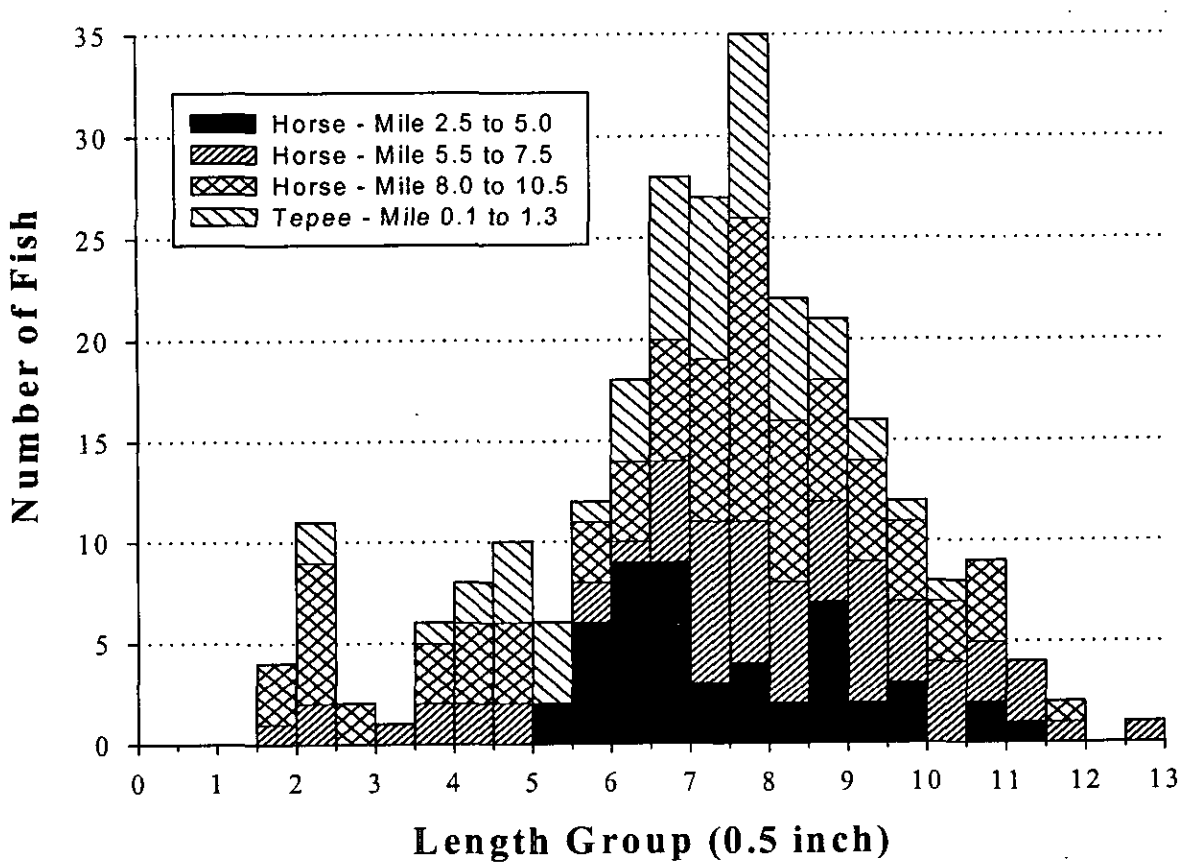

Figure 29. Length frequencies for westslope cutthroat trout captured in Horse and Tepee creeks during 1997 grouped by portion of the stream where they were captured.

Hyde Creek

Hyde Creek, a 6.5 mile-long stream, drains the Gravelly Range and enters the Madison River from the west. It originates and flows through the Beaverhead-Deerlodge National Forest in its upper reaches, while its lower two miles flow through Montana Fish, Wildlife and Parks' Wall Creek Wildlife Management Area (Figure 1). Hyde Creek has one major tributary, the South Fork Hyde Creek, which flows through steep, coniferous forest before entering main Hyde Creek approximately 4.5 miles above its mouth. The South Fork is approximately 3.5 miles long. Hyde Creek originates in relatively open meadows, then flows through steep, coniferous forested lands in its middle reach before flowing through a decadent beaver pond complex in a transitional zone with mixed coniferous and deciduous trees between stream mile 2.3 and 2.6. An old 10 foot-high beaver dam located near stream mile 2.4 was deemed a total barrier to upstream fish movement (Figure 4). An old 5 foot-high beaver dam located near stream mile 2.3 was not a barrier to upstream fish movement because brown trout were captured above this dam. Livestock impacts to the stream channel were observed between stream mile 2.5 and 3.4 during a survey of the stream in 1997. After leaving the beaver complex, Hyde Creek flows under the Wall Creek Road and then through grassland terraces before entering the Madison River. A road ford where woody debris had accumulated located near an old homestead near stream mile 0.9

may limit upstream fish movement. Numerous side channels were observed in Hyde Creek between the old homestead and Wall Creek Road. The Montana FWP fish planting database did not include any records of fish planting in the Hyde Creek drainage.

Habitat

An Optic Stowaway® thermograph was placed in Hyde Creek near the Wall Creek Road from June 25 to October 6, 1997 (Figure 3). During the summer daily temperatures generally averaged around 50°F, with maximum daily temperatures never going above 60 °F (Figure 30). In 1999 four Optic Stowaway® thermographs were placed in several locations in Hyde Creek from its mouth up to mile 4.5 and one was placed in the South Fork above its mouth at main Hyde Creek. In lower Hyde Creek maximum summer temperatures approached 70°F, while average daily temperatures were usually between 55 to 60°F (Figure 31). Water temperatures were progressively cooler moving in an upstream direction in main Hyde Creek, while the South Fork had the coolest water temperatures.

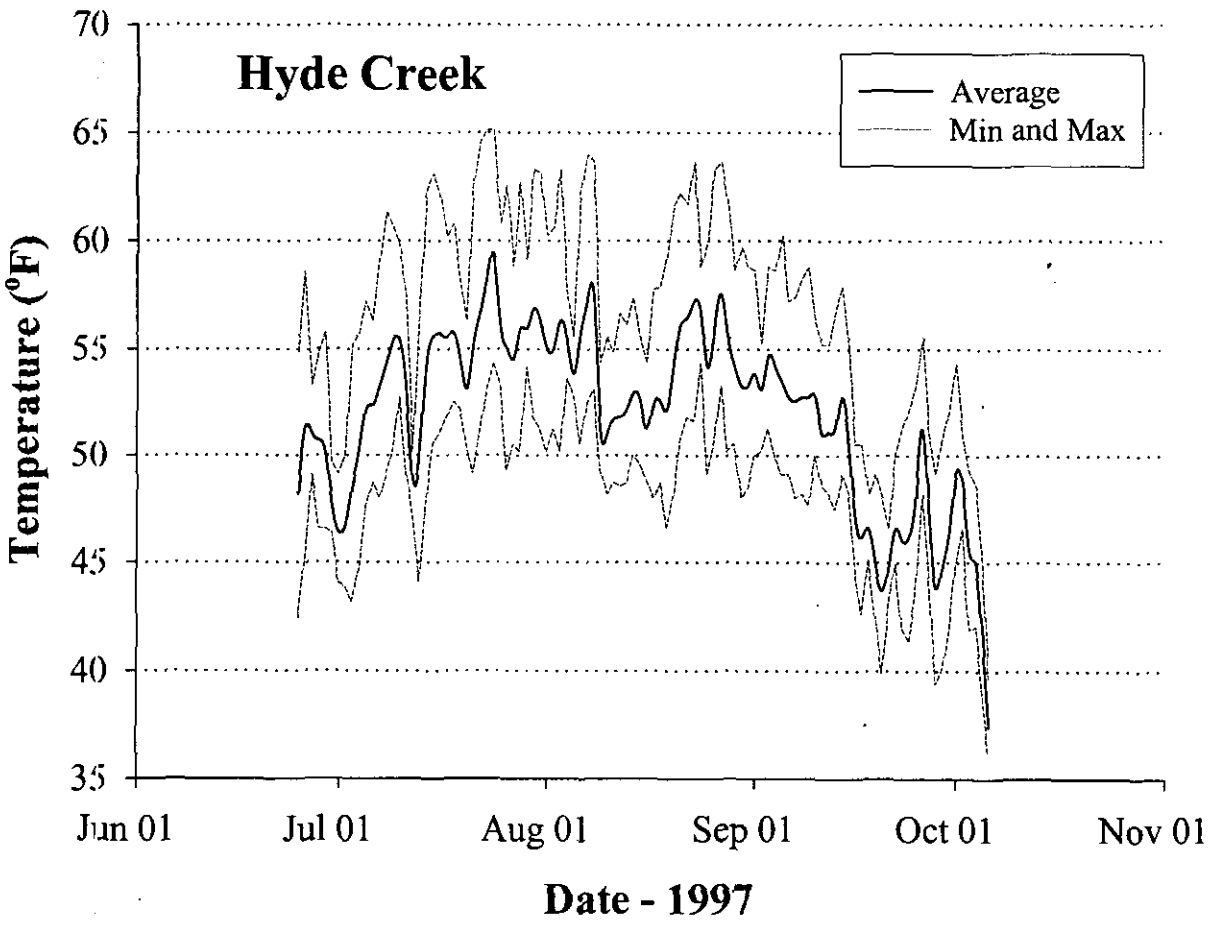

Figure 30. Average, minimum and maximum daily water temperatures recorded in Hyde Creek near the Wall Creek Road in 1997.

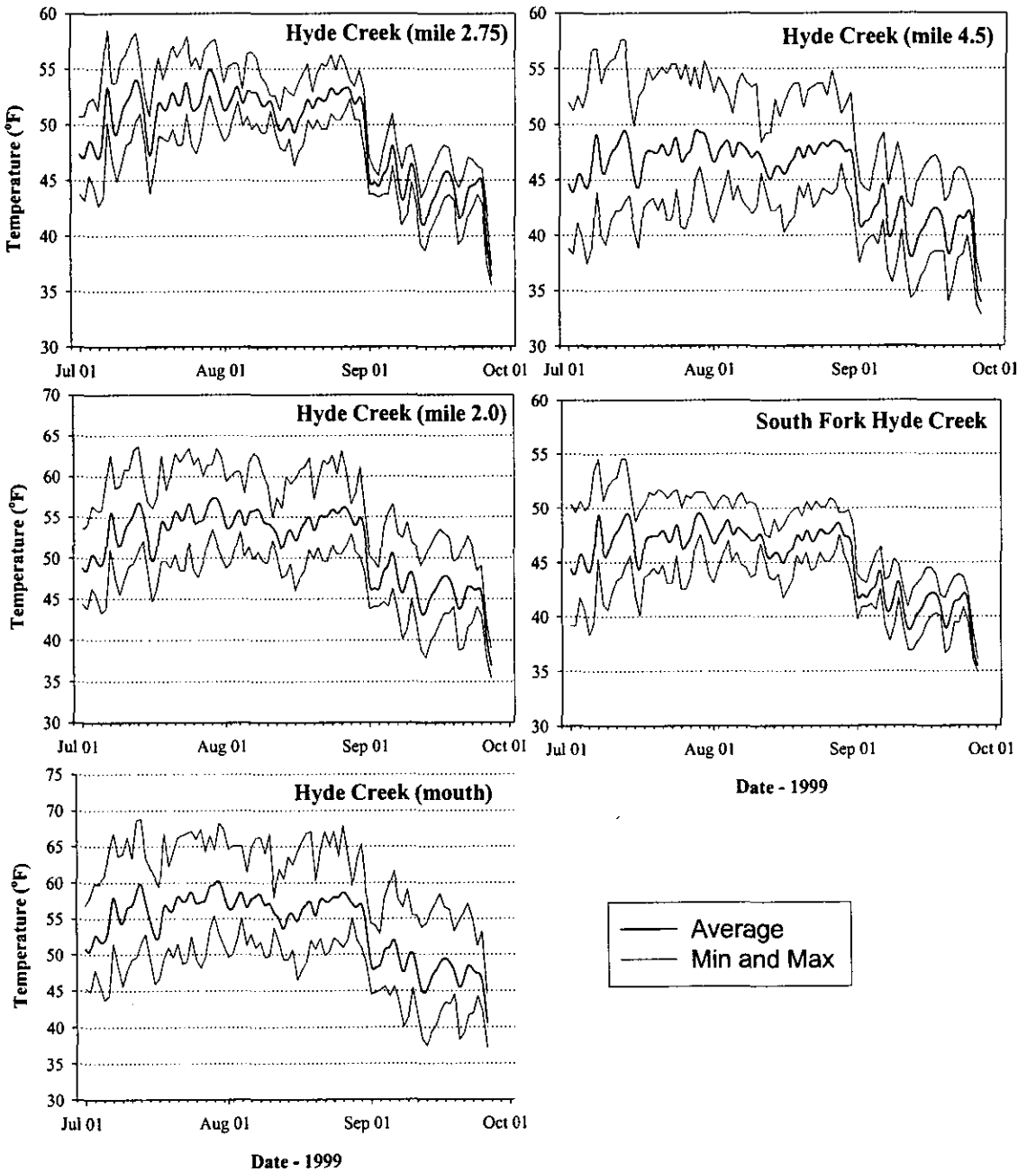

Figure 31. Average, minimum, and maximum water temperatures during the summer of 1999 in four locations in Hyde Creek and one location in the South Fork of Hyde Creek.

A reach survey was conducted in Hyde Creek from its mouth at the Madison River upstream about 4.1 miles. This reach survey was broken into 5 segments (Appendix A). Pool and run habitats dominated the lower two segments, below the Wall Creek Game Range Road, while riffle and pool habitat types comprised nearly equal proportions of the channel from the Wall Creek Game Range Road up to stream mile 4.1 (Table 1).

A detailed habitat survey was conducted at mile 3.5 in Hyde Creek. At stream mile 3.5 the streambed was predominated by large (boulders and cobble) particles (Table 2). Woody debris was extremely abundant and much of this debris extended across the channel. Spawning habitat was very limited, but probably adequate. Instream and bank cover, bank stability, and pool quality were all very high, and use of riparian habitats was low (Table 3).

Fish Distribution and Abundance

Brown trout were found only in the lower portion of Hyde Creek (stream miles 0.2, 0.5, 1.6, and 2.4) below the large decadent beaver dam at mile 2.4 (Figure 32 and Appendix D). Only westslope cutthroat trout were found above this dam. Sculpins were only observed in the lowermost section (mile 0.2). No fish were observed or captured in three sections at stream miles 1.0, 1.4, and 2.0 below the Wall Creek Road. It appeared that very few brown trout and no westslope cutthroat trout were using Hyde Creek from stream mile 0.5 all the way up to the bottom end of a beaver complex located at about mile 2.4. This beaver pond complex was believed to be a barrier to upstream movement by fish inhabiting the lower drainage. Physical habitat in the portion of the creek from the beaver complex down to mile 0.5 appeared to be suitable for trout, but was not occupied.

Three westslope cutthroat trout sampled in 1995 above this beaver complex were found to contain 96% alleles characteristic of westslope cutthroat trout and 4% characteristic of rainbow trout, while two westslope cutthroat trout sampled in the same area in 1997 were found to contain some characteristics of Yellowstone cutthroat trout at two alleles (Table 5). Differentiation between westslope cutthroat and rainbow trout could not be made from the samples taken in 1997 due to a freezer malfunction (letter from Naohisa Kanda and Robb Leary to Brad Shepard dated November 2, 1998). Genetic sampling was repeated at several locations in 1999 to clarify the genetic status of this population. DNA analyses through PINE markers of fin clips from 16 fish revealed that the westslope cutthroat trout in Hyde Creek also contained genetic material from Yellowstone cutthroat trout (4%) (Letter from Naohisa Kanda to Brad Shepard dated March 27, 2000) (Table 5).

Relative abundance of westslope cutthroat trout increased from stream mile 2.4 up to mile 3.5, and then declined at mile 4.0. No westslope cutthroat trout were captured at stream mile 2.4 in 1997, but they were found at this location in 1999. In contrast, brown trout were found at this location in 1997, but not found in 1999. No fish were captured at stream miles 4.5, 4.6, or 5.0. A waterfall located at stream mile 4.1 was believed to be a barrier to upstream fish movement and no fish were observed above this barrier. No fish were observed or captured in a 165-foot section of the South Fork of Hyde Creek at mile 0.25. The South Fork consisted of a series of small step-pools inter-mixed with cascades throughout its lower 0.5 mile and no fish were observed.

A depletion population estimate was made in Hyde Creek at stream mile 3.5. The 331 foot-long sample section supported an estimated 37 westslope cutthroat trout (SE: 0.9), with 18 of these fish (SE: 0.5) between 3 and 6 inches long and 19 (SE: 0.8) between 6 and 12 inches (Appendix E). This estimate translates to an estimated 112 westslope cutthroat trout 3.0 inches and longer per 1,000 feet of stream length.

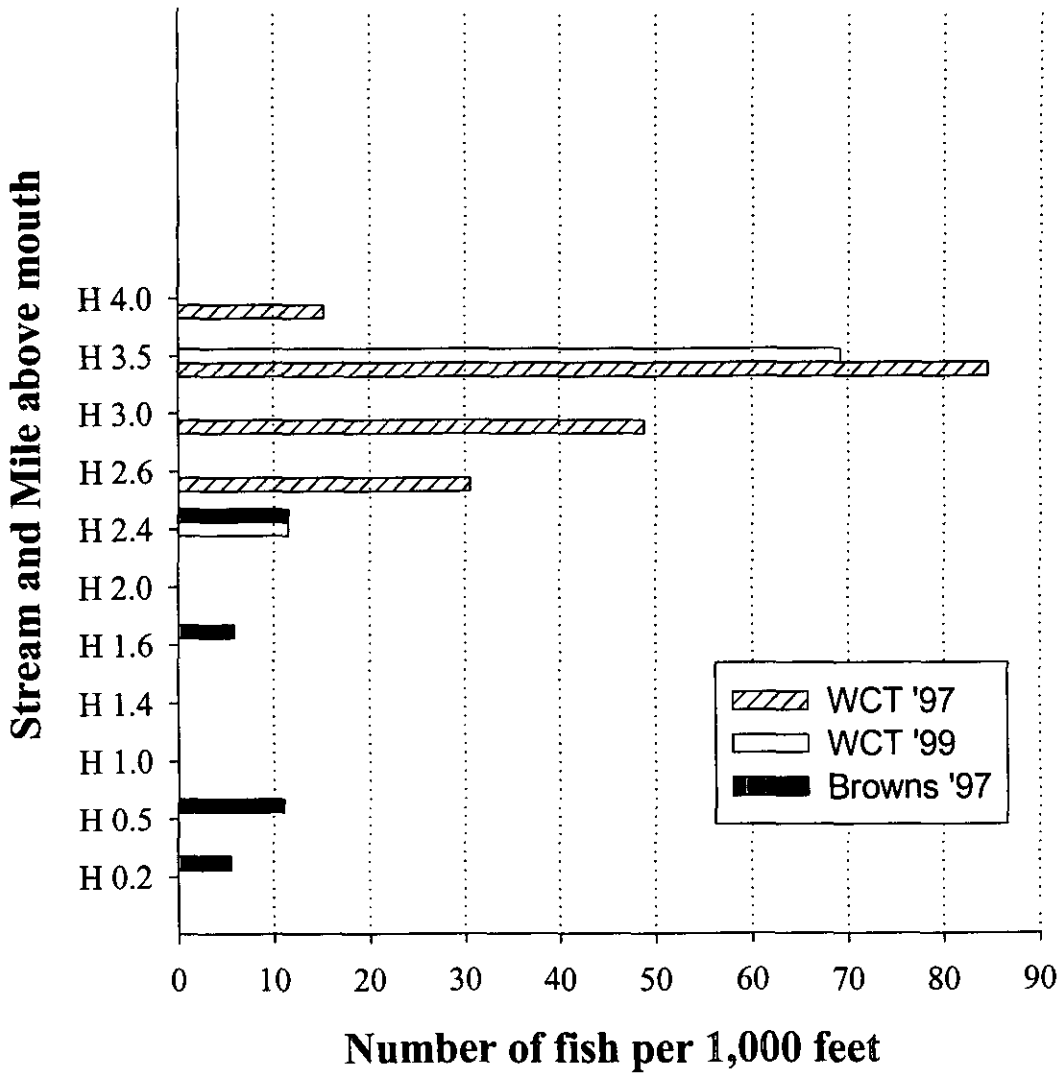

Figure 32. Catch of westslope cutthroat trout (WCT) and brown trout 3.0 inches and longer per 1,000 feet of stream length in 1997 and 1999 in 14 sections of Hyde creek (H with stream mile) and one section of the South Fork Hyde Creek (S with stream mile). All stream mile sections on the y-axis were sampled and zero values indicate no fish were captured.

Fish Length and Weight

The few brown trout captured in lower Hyde Creek were mostly 4.0 to 5.5 inches with one 8.5 inches long (Appendix F and Figure 33). The smaller (< 3.5 inch) westslope cutthroat trout captured in Hyde Creek were mostly captured at the lower portion of their distribution (mile 2.6) and most captured westslope cutthroat trout were between 4.5 and 7.0. Average lengths of captured westslope cutthroat trout increased in an upstream direction (Appendix F).

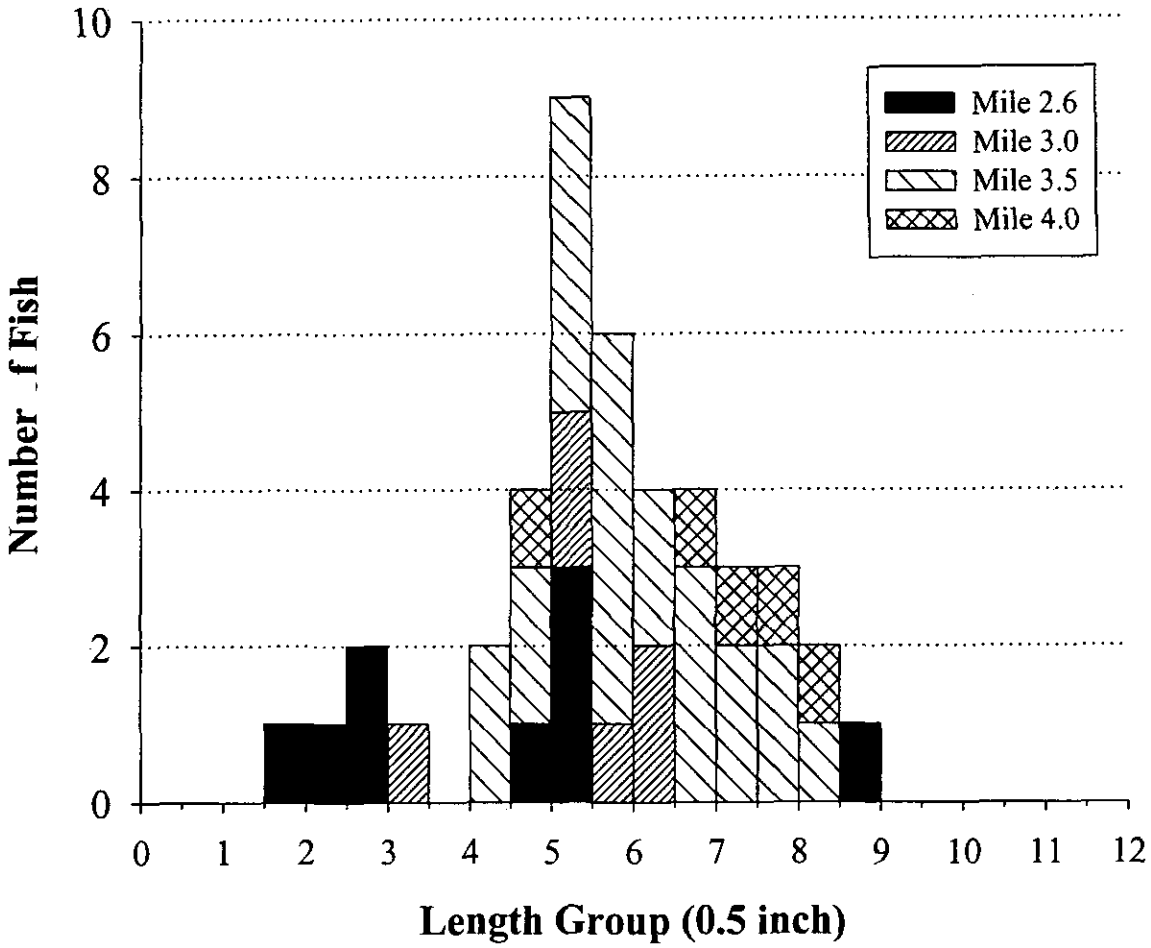

Figure 33. Length frequencies of westslope cutthroat trout captured in Hyde Creek by stream mile (bar patterns).

Comparison to Previous Sampling

These results were similar to results from sampling done in 1995 (J. Brammer, Montana FWP, Dillon, MT; files). That sampling found a few smaller brown trout near stream mile 0.8; no fish below the Wall Creek Road at about stream mile 1.9; and a relatively low population of westslope cutthroat trout (an estimated 24 3.0 inches and longer per 1,000 feet of stream length) at about stream mile 2.9.

Indian Creek

Indian Creek is one of the largest streams draining the Madison Range, flowing approximately 17 miles before entering the Madison River from the east (Figure 1). In its upper reaches, the stream meanders through low gradient, open meadows interspersed with patches of conifer forest. Thirteen miles above its mouth Indian Creek enters a narrow canyon that extends 1.5 miles downstream. After leaving the canyon the stream then flows through conifer forest interspersed with open meadows until it reaches the Madison valley. Most, if not all of Indian Creek is diverted into the Indian Creek Ditch a short distance downstream of the Forest Service boundary (stream mile 5.5). During the summers of 1998 and 1999, Indian Creek was completely dry a short distance downstream from the Indian Creek Ditch. Raw Liver Creek, McAtee Creek, Manley Creek, Shedhorn Creek, No Man Creek, the South Fork of Indian Creek and several small, unnamed streams are tributaries to Indian Creek. Manley Creek is a 2.0 mile-long stream entering Indian Creek from the north. Approximately 0.25 miles upstream of the mouth of Manley Creek a steep cascade resulting in a 6-foot drop in the stream channel may prohibit upstream movement of fish. Shedhorn Creek is a 5.5 mile-long stream entering Indian Creek from the south. Shedhorn Creek flows through a narrow valley with abundant downfall and debris over the stream. Raw Liver Creek is a 1.5 mile-long tributary to upper Indian Creek. Raw Liver Creek, along with many other unnamed tributaries in the upper Indian Creek basin appear to be to small to support resident fish populations. Of the named and unnamed tributaries to Indian Creek only McAtee Creek, No Man Creek, and the South Fork of Indian Creek support resident trout populations. Results from sampling of these tributaries are reported in subsequent sections.

The Montana FWP fish planting database indicates that between 8/21/31 and 9/27/48 a total of 99,200 unidentified cutthroat trout were planted in Indian Creek near the stream's mouth (Appendix G). Between 10/09/47 and 8/13/48 a total of 32,000 rainbow trout were also planted near the mouth of Indian Creek. The last recorded planting for Indian Creek occurred on 10/1/51, when 5,800 Yellowstone cutthroat trout were released near the stream's mouth.

Habitat

An Onset Optic Stowaway® thermograph was placed in Indian Creek just above the mouth of the South Fork of Indian Creek on June 20, 1998 and left to record stream temperatures until October, 20, 1998 (Figure 3). In 1998 stream temperatures remained cool, with an average temperature of 45.9°F (Figure 34). Stream temperatures fluctuated 2.0 to 11.6°F daily, and never exceeded 56°F.

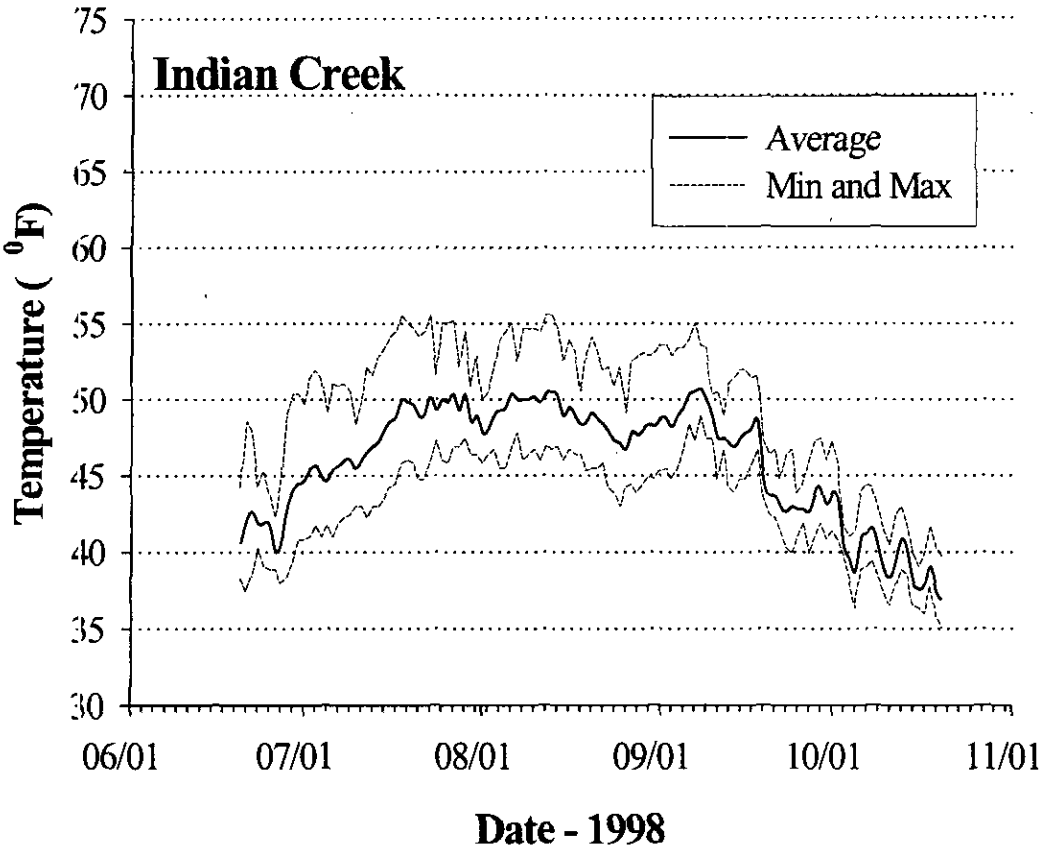

Figure 34. Average, minimum, and maximum stream temperatures in Indian Creek just above the mouth of the South Fork of Indian Creek (stream mile 6.0) during 1998.

In 1999 Onset Optic Stowaway® thermographs were placed in Indian Creek at stream miles 6.0, 8.5, 13.25, and 16.0 on July 9 and left to record stream temperatures until September 27. During this same period, thermographs were also placed in Manley and Shedhorn creeks near their mouth to record summer stream temperatures. In Indian Creek, mean stream temperatures ranged from 44.6 to 48.2°F, peaking at stream mile 13.25 but otherwise cooling in an upstream direction (Figure 35). Maximum stream temperatures also peaked at stream mile 13.25 and ranged from 53.6 to 62.9°F. Stream temperatures fluctuated from <1.0 to 10.3°F daily at the lower two thermograph sites and from 2.0 to 20.45°F daily at the upper two thermograph sites. In Manley Creek, the average summer temperature remained cool at 45.3°F (Figure 36). In Shedhorn Creek, the average summer temperature was also cool at 45.8°F (Figure 36).

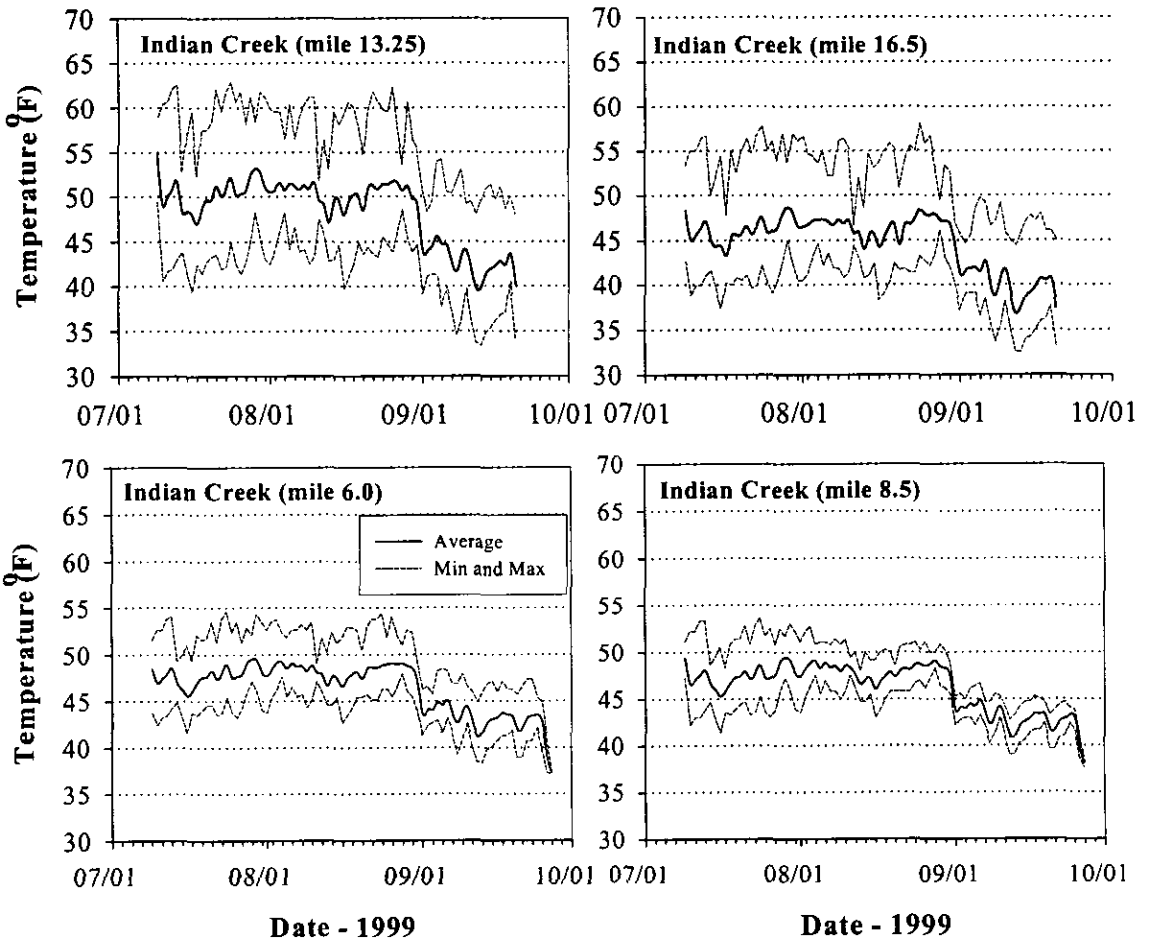

Figure 35. Average, minimum, and maximum daily water temperatures at four locations in Indian Creek during the summer of 1999.

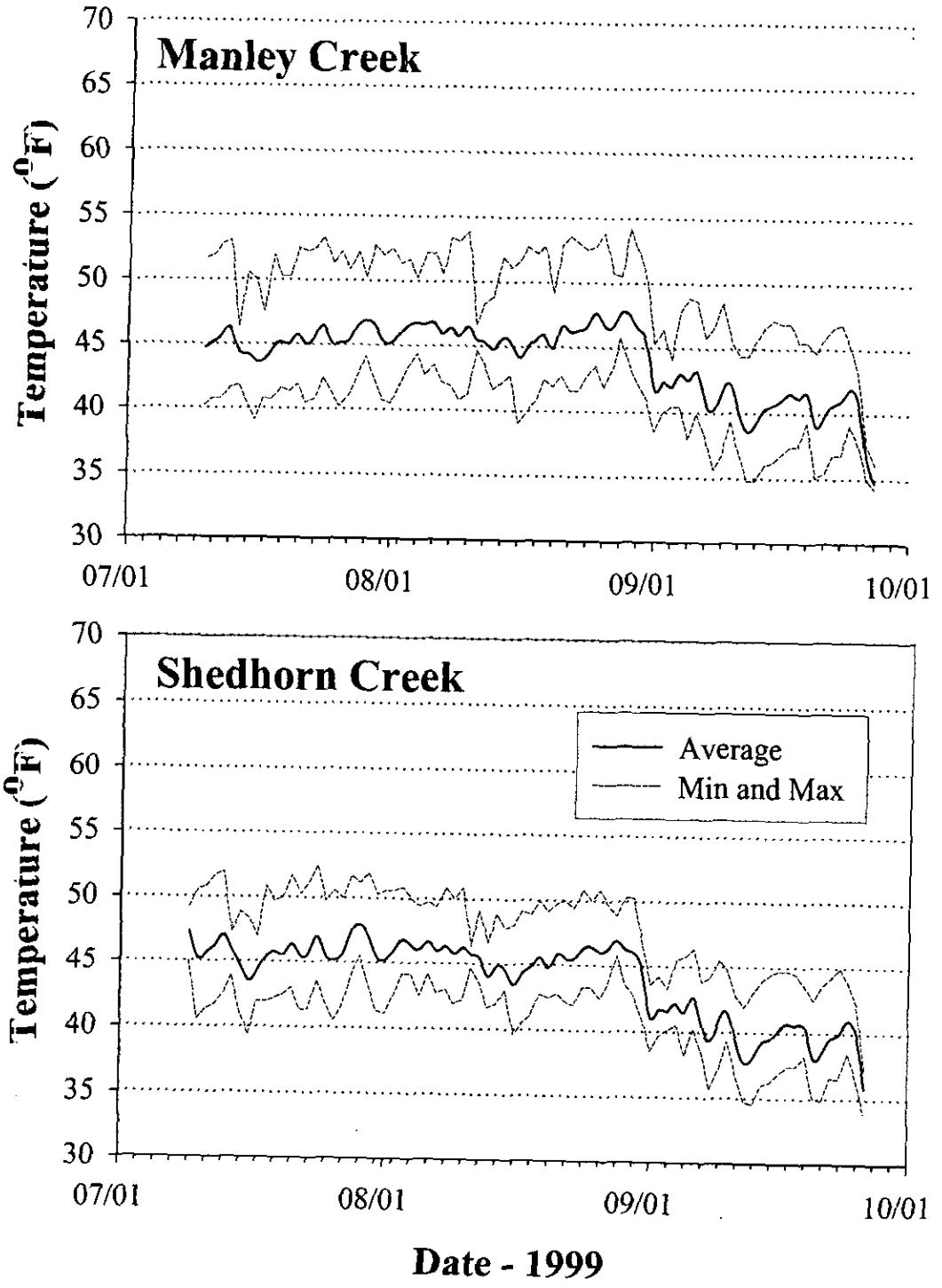

Figure 36. Average, minimum, and maximum daily water temperatures near the mouths of Manley (top) and Shedhorn (bottom) creeks, tributaries to Indian Creek, during the summer of 1999.

Indian Creek

A reach survey was conducted in upper Indian Creek from the mouth of McAtee Creek upstream 3.0 miles to the first unnamed tributary upstream of Raw Liver Creek (this represents the upstream distribution of trout in Indian Creek). Riffle and pool habitat types dominated this reach, comprising nearly equal proportions of the stream channel (Table 1). High gradient riffles dominated riffle types, while lateral scour pools dominated pool types.

Detailed habitat surveys were conducted in Indian Creek at stream miles 14.0 and 16.0. At stream mile 14.0 the streambed was dominated by large gravel and cobble substrate (Table 2). Woody debris was abundant but little of this debris extended across the stream channel. Spawning gravels were relatively abundant, but excessive fine sediment may limit spawning habitat at this site. Instream cover, bank cover, and bank stability were moderate. Pool habitat was somewhat limited but probably adequate (Table 3). Riparian habitat was used extensively by wildlife. At stream mile 16.0 the streambed was dominated by small gravel (Table 2). Woody debris was extremely abundant and much of this debris extended across the stream channel. Spawning habitat was also extremely abundant. Instream cover, bank cover, bank stability and pool habitat were all moderate (Table 3). Riparian use by wildlife was relatively high. Average wetted widths ranged from 6.7 to 11.2 feet, and average water depth ranged from5.3 to 6.4 inches.

Manley, Shedhorn, and Raw Liver creeks

No habitat data were collected for Manley Creek, Shedhorn Creek, or Raw Liver Creek because no fish were captured in those streams.

Fish Distribution and Abundance

Indian Creek

Rainbow trout were captured by electrofishing at stream miles 13.5, 14.0, 14.5, 15.0, 15.5, and 16.0. No other fish species were observed or captured. The relative abundance of rainbow trout was low to moderate in Indian Creek, ranging from 9.1 to 31.3 trout greater than 3 inches per 1000 feet of stream (Figure 37 and Appendix D).

Two-pass depletion population estimates were made in Indian Creek at stream miles 14.0 and 16.0 (Figure 38 and Appendix E). At stream mile 14.0 a 328 foot-long sample section supported an estimated 13 rainbow trout (SE: 1.0), with 3 of these fish (SE: 1.76) between 3 and 6 inches, and 10 fish (SE: 0.09) between 6 and 12 inches. This translates into an estimated 40 fish 3 inches and longer per 1,000 feet of stream (Figure 38). At stream mile 16.0 a total of three rainbow trout between 6 and 12 inches long were captured in a 302 foot-long sample section. No fish were observed or captured during the second electrofishing pass. This translates into an estimated 10 rainbow trout 3 inches and longer per 100 feet of stream at mile 16.0 (Figure 38).

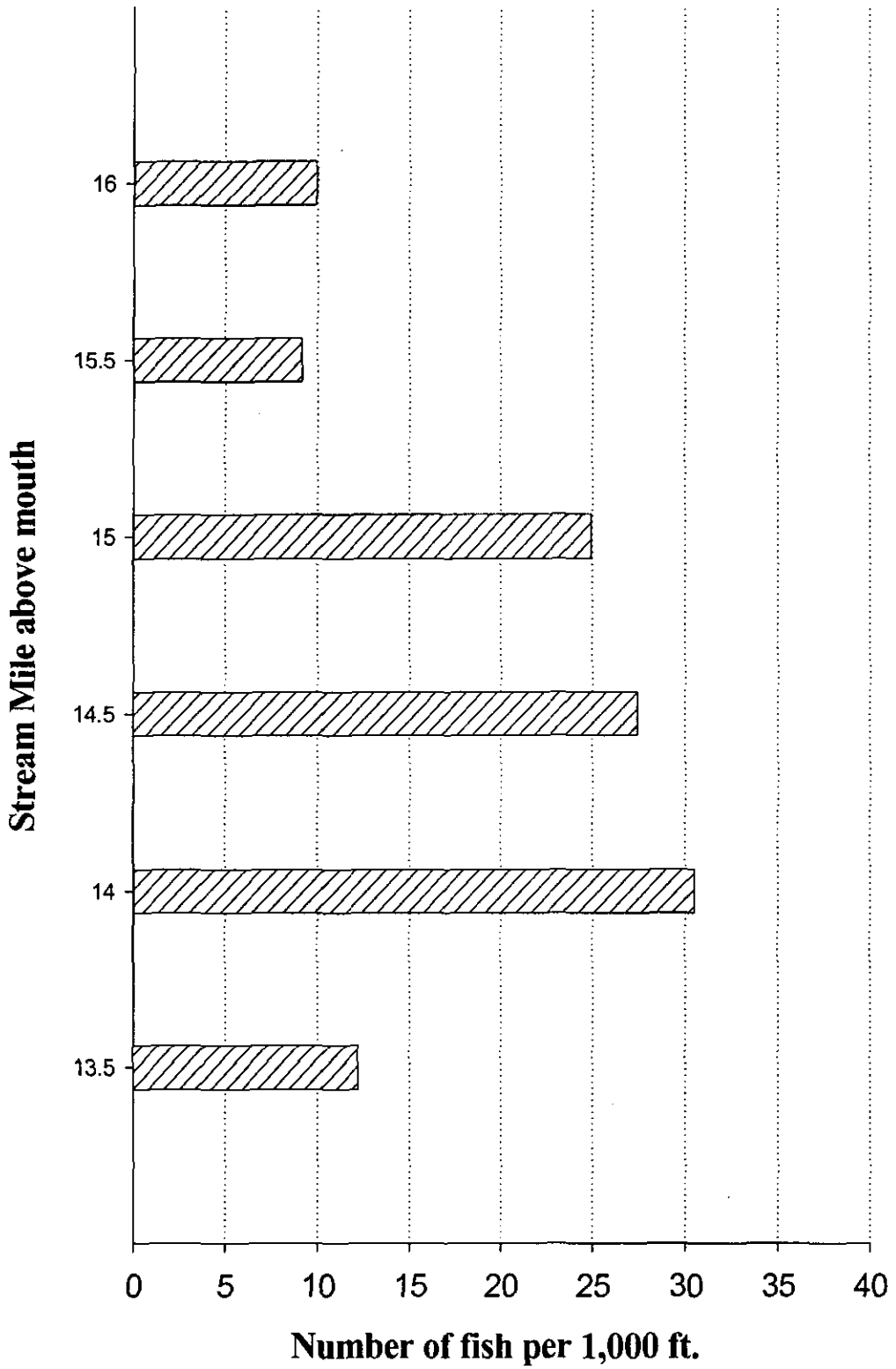

Figure 37. Catch of rainbow trout 3 inches and longer per 1,000 feet of stream length in sample sections of Indian Creek during the summer of 1998.

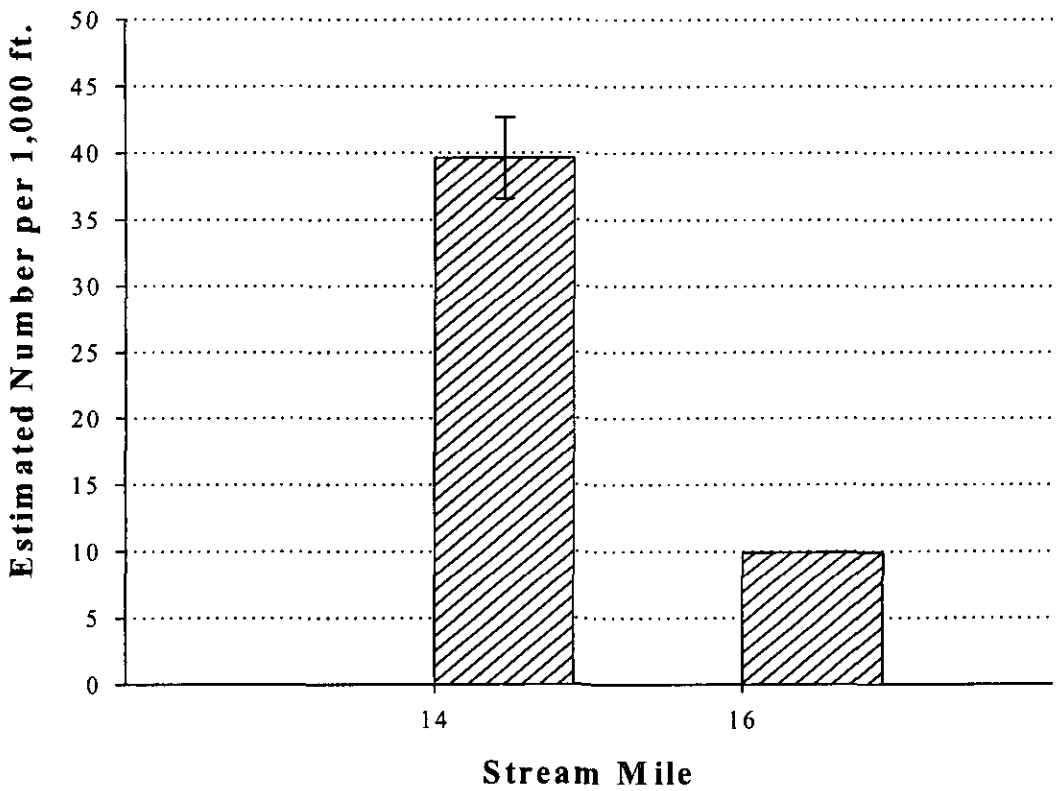

Figure 38. Estimated number of rainbow trout 3.0 inches and longer in Indian Creek by stream mile. Vertical lines represent standard errors.

We were unable to backpack electrofish Indian Creek below the mouth of McAtee Creek (stream mile 13.5) because of its large size. A towed electrofishing unit would be the ideal tool for sampling lower Indian Creek if not for the difficult access and the prohibition of motorized equipment within the Lee Metcalf Wilderness Area. During August of 1999, we attempted to obtain a mark recapture population estimate at stream mile 7.5 by capturing fish via angling and then snorkeling to obtain a visual recapture run. Unfortunately, summer thunderstorms muddied Indian Creek during this period and only six rainbow trout were captured during the marking run. The effort was abandoned because of low capture efficiencies and poor visibility.

Manley Creek

Single pass electrofishing efforts were made above the potential barrier in Manley Creek at stream miles 0.5 and 1.0. No fish were observed or captured in either 270 foot-long sample section.

Shedhorn Creek

Single pass electrofishing efforts were made at stream miles 0.5 and 1.0. At stream mile 0.5, no fish were observed or captured in a 393 foot-long sample section. Likewise, at stream mile 1.0 no fish were observed or captured in a 328 foot-long sample section.

Raw Liver Creek

Raw Liver Creek appears to small to support a resident fish population. A single-pass electrofishing effort was made in Raw Liver Creek just above its mouth. No fish were observed or captured in the 196 foot-long sample section.

Fish Length and Weight

Rainbow trout captured in Indian Creek ranged from 2.2 to 10.7 inches long (Appendix F). Average lengths ranged between 5.3 and 8.5 inches and generally increased in upstream sample sections. Rainbow trout less than 6 inches in length were not captured in sample sections above stream mile 14.5 (Figure 39).

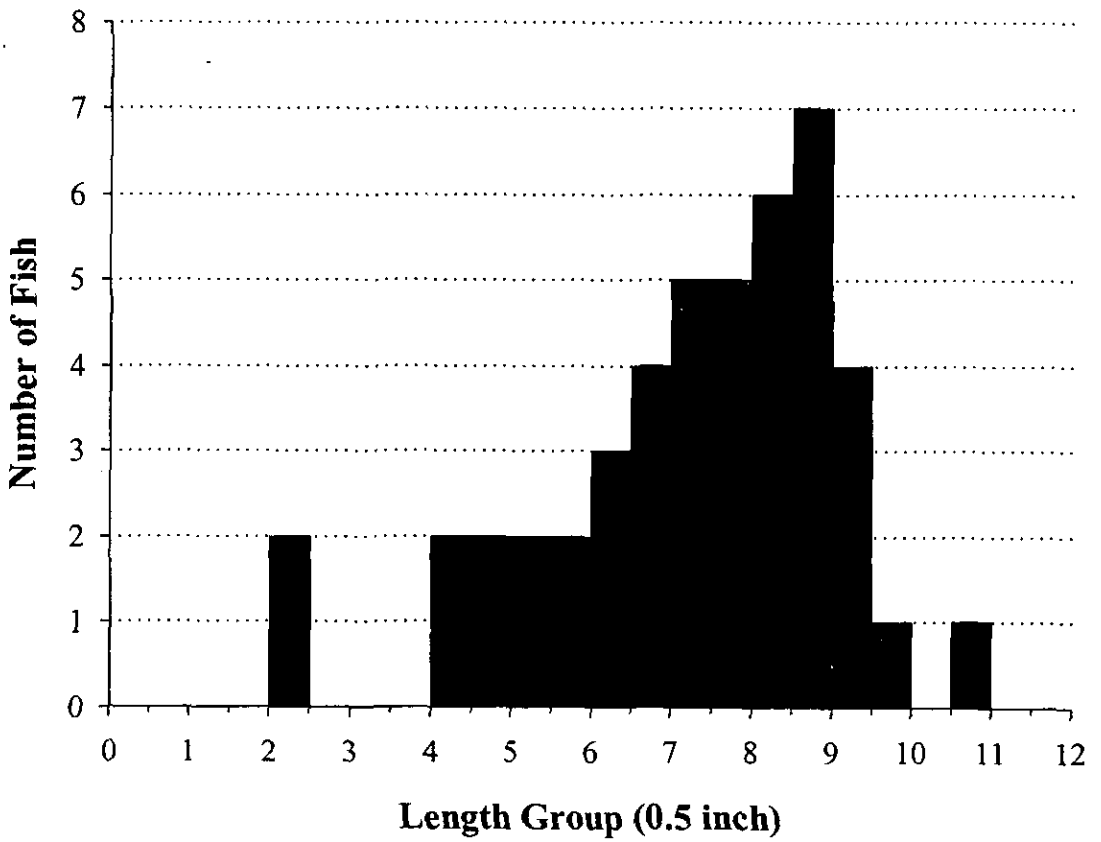

Figure 39. Length frequencies for rainbow trout captured in Indian Creek during 1998.

Comparisons to Previous Sampling

A previous inventory conducted in August 1980 found that the reach of Indian Creek below No Man Creek supported an estimated 160 rainbow trout per 1000 feet of stream (MRIS). Rainbow trout captured during this inventory ranged between 3 and 12.9 inches long. The densities of rainbow trout we observed in upper Indian Creek from 13.5 to 16.0 miles above the stream's mouth were considerably lower than those reported during this previous survey (Figure 37). However, since we could not sample below No Man Creek we cannot directly compare our results to this previous sampling.

Lake Creek

Lake Creek drains Wade Lake via a groundwater connection at the southern end of the Gravelly Range and enters the West Fork Madison River from the south. It originates below Wade Lake as a series of springs and flows north between the Wade Lake and Cliff Lake benches through the Beaverhead-Deerlodge National Forest (Figure 1). It flows into an irrigation reservoir, Smith Lake, about 0.2 miles above its mouth. The dam on Smith Lake appears to allow some passage of spawning brown trout into upper Lake Creek from the Madison River (based on radio-tagged brown trout relocations; Pat Byorth, Montana FWP, Bozeman, Montana; personal communication). Lake Creek flows through a relatively broad valley trough with mixed sedge, grasses and willow from its source to Smith Lake. Below Smith Lake the channel is steeper, more confined, and flows through coniferous forest. The channel is braided immediately above Smith Lake and has little defined pool habitats in the lower half of the channel. Based on the Montana FWP fish planting database there are no records of any fish being planted in the Lake Creek drainage, including into Smith Lake.

Habitat

No detailed habitat surveys were conducted in Lake Creek. Casual observation indicated that Lake Creek had abundant spawning habitat of relatively high quality. The channel above Smith Lake was braided and did not flow in a confined channel, but spread over the valley floor. Little pool development was seen throughout most of the lower portion of the stream above Smith Lake.

Fish Distribution and Abundance

Brown trout were the only species sampled in Lake Creek above Smith Lake. Three sections above Smith Lake were sampled during late June 1998. The relative abundance of brown trout 3.0 inches and longer was highest in the middle section (mile 1.6) and lowest in the upper section (mile 2.1; Figure 40 – top graph; and Appendix D). Three-pass depletion population estimates were also made in all three sections. Capture efficiencies were relatively poor in all sections (< 50%) due to the broad shallow unconfined channel and relatively small fish, but were especially poor in the lower section (mile 1.1; efficiency of about 30%). Estimated populations were extremely high in the lower two sections (at least 500 brown trout 3.0 inches and longer per 1,000 feet of stream channel), but were lower in the upper section (Figure 40 – bottom graph; and Appendix E).

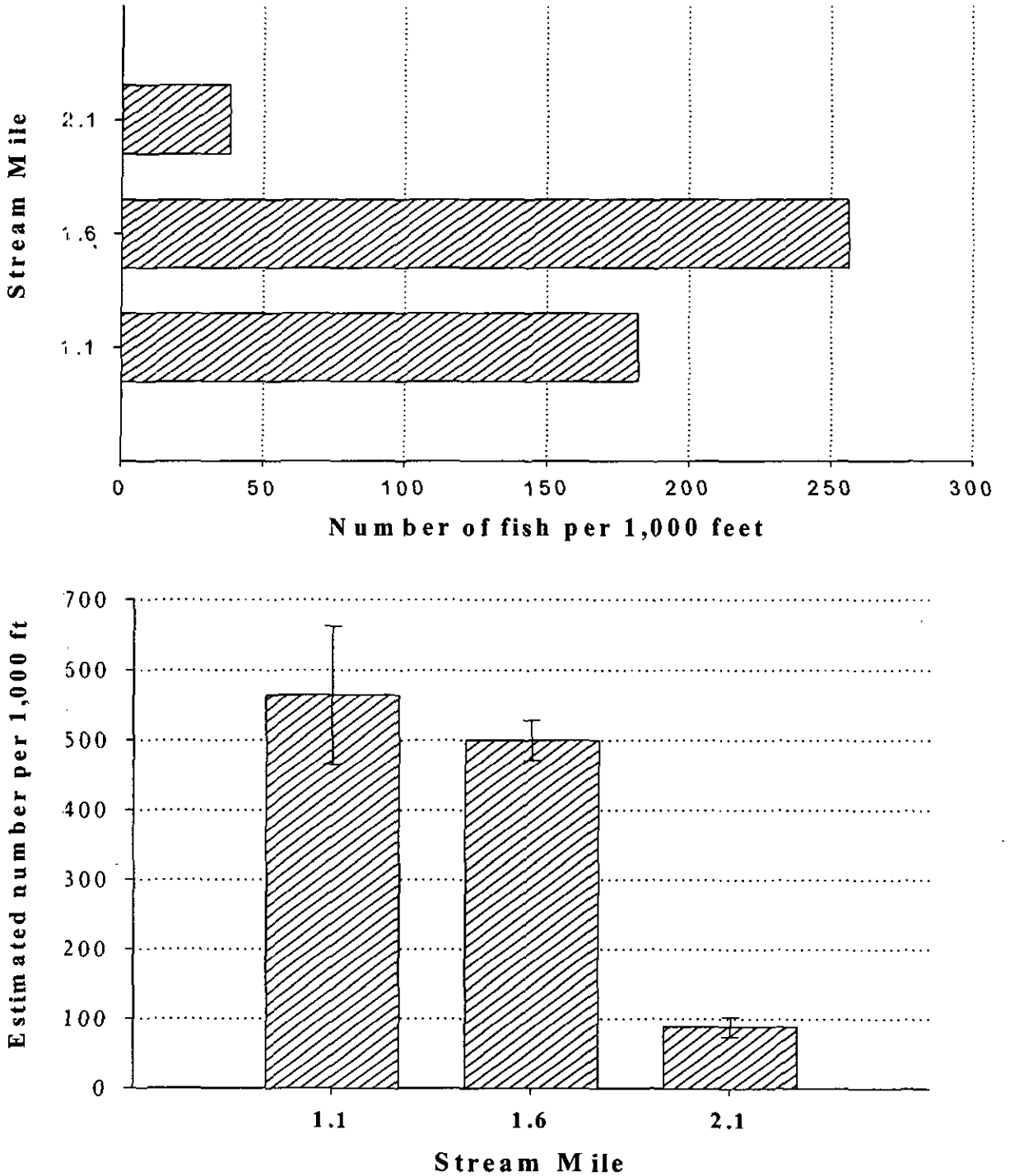

Figure 40. Catch (top) and estimated number (bottom) of brown trout 3.0 inches and longer per 1,000 feet of stream length in three sections of Lake Creek (by stream mile on y-axis for top graph and x-axis for bottom graph) in 1998. Standard errors are shown as vertical lines on bottom graph.

Fish Length

Length frequencies of captured brown trout indicated that few age 0 fish (< 3 inch) were captured in late June, however, most of the captured fish appeared to be about age 1 (3-6 inch; Figure 41). Very few fish longer than 10 inches were captured. Average lengths for captured brown trout were about 5.0 inches for all three sections (Appendix F).

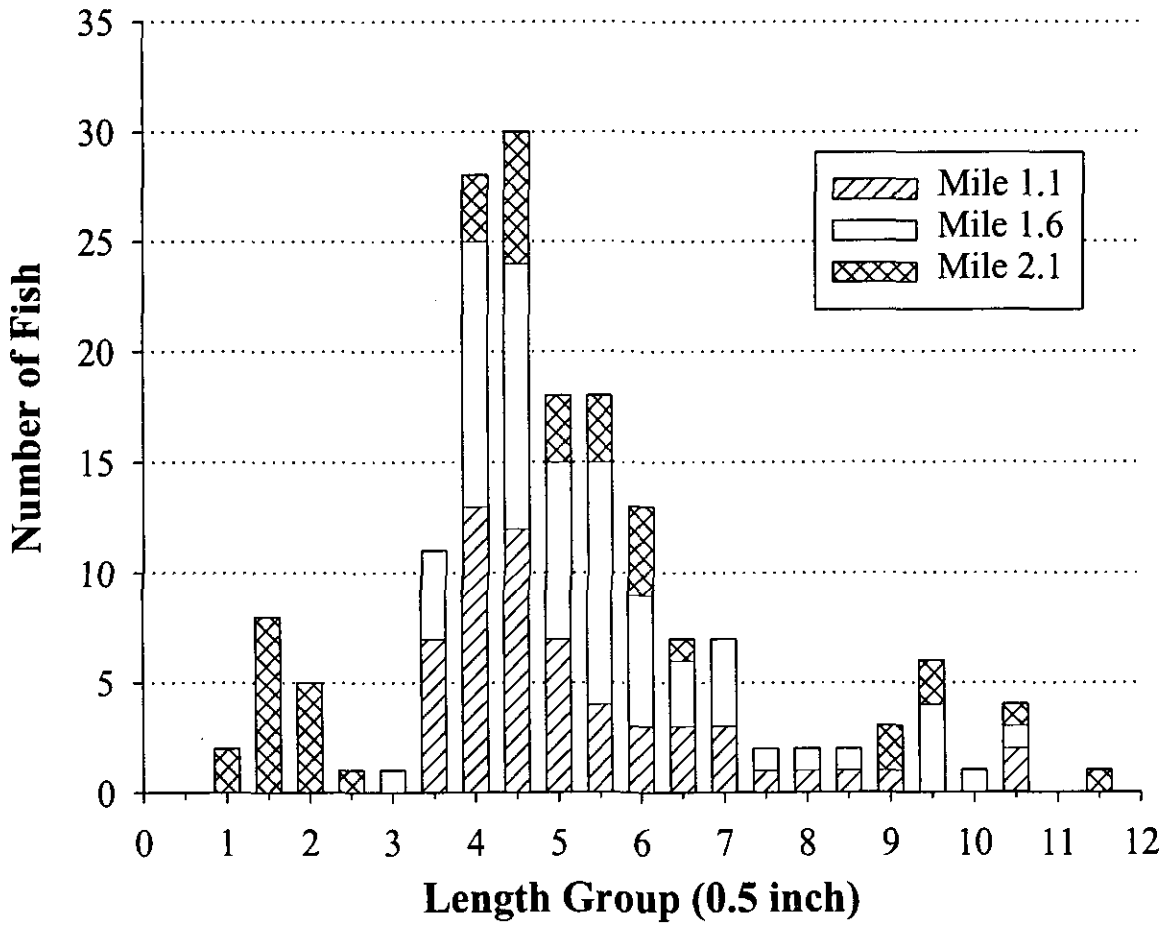

Figure 41. Length frequency histograms of brown trout captured in Lake Creek by stream mile during 1998.

Comparison to Previous Sampling

There are no records in the MRIS for Lake Creek, however, Jim Brammer documented that rainbow trout use Lake Creek below Smith Lake for spawning (Jim Brammer, Montana FWP, Dillon, personal communication) and Pat Byorth (Montana FWP, Bozeman, personal communication) has documented brown trout using Lake Creek for spawning.

McAtee Creek

McAtee Creek is a tributary to Indian Creek, draining the Madison Range. McAtee Creek is approximately 5 miles in length, flowing predominately through coniferous forest. It originates in the Beaverhead-Deerlodge National Forest, with its lower 2.5 miles flowing within the Lee Metcalf Wilderness Area. A 35 foot-high waterfall is present at stream mile 2.0, and another 50 foot-high waterfall is located a short distance upstream from the first falls. McAtee Creek has four major tributaries: Circle Creek, Cougar Creek, Gorge Creek, and an unnamed tributary. Circle Creek enters McAtee Creek just above its confluence with Indian Creek. The stream is approximately 2.5 miles long, with the upper 2 miles of stream flowing through a series of low gradient grassy meadows interspersed with small conifer stands. The lower half-mile of stream flows through a more confined and higher gradient valley bottom bordered by coniferous forest. Gorge Creek is a 2.5 mile-long stream entering McAtee Creek from the east. A 20 foot-high waterfall located approximately 0.75 miles upstream from the mouth of Gorge Creek prevents upstream fish migration. Above the waterfall the stream flows through a low gradient meadow where the channel is highly sinuous. Below the waterfall the stream enters the narrow high gradient gorge that gives the creek its name. A short distance upstream from Gorge Creek a 1.5 mile-long unnamed tributary enters McAtee Creek from the east. A 25 foot-high waterfall is located approximately 0.25 miles above the mouth of the unnamed tributary. Cougar Creek enters McAtee Creek from the northwest a half-mile upstream from the unnamed tributary. A few hundred yards from its mouth two waterfalls are present, resulting in a 100 foot drop in the stream channel. This set of falls appears to be on or near to the same contour (8,000 foot line) as the waterfall on McAtee Creek, Gorge Creek, and the unnamed tributary to McAtee Creek, suggesting some type of geological fault or schism has isolated the headwaters of these streams for a significant amount of time (J. Brammer, Montana FWP, Dillon, MT, files)

The Montana FWP fish planting database indicates that 8,000 rainbow trout were planted in Circle Creek on 8/04/48, and an additional 8,000 rainbow trout were planted on 8/13/48 (Appendix G).

Habitat

During 1999 an Onset Optic Stowaway® thermograph was placed in McAtee Creek near its mouth on July 9 and left to record stream temperatures until September 20 (Figure 3). Mean summer temperature for this period was 48.5°F. Stream temperatures fluctuated 3.1 to 19.6°F daily, with a maximum stream temperature of 62.4°F (Figure 42).

McAtee Creek

A reach survey was conducted in McAtee Creek from its mouth at Indian Creek upstream approximately 2 miles to the first waterfall. Riffle and pool habitat types dominated this reach, comprising nearly equal proportions of the stream channel (Table 1). High gradient riffles dominated riffle types, while lateral scour pools and plunge scour pools were seen in nearly equal numbers.

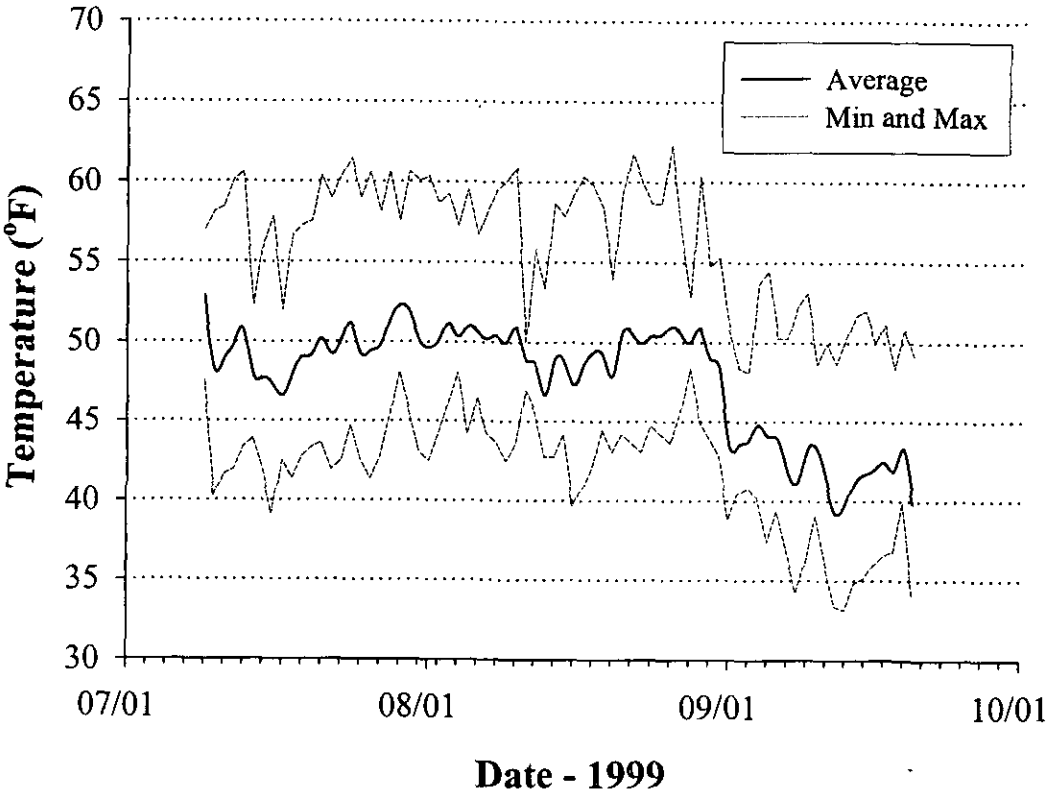

Figure 42. Average, minimum, and maximum daily water temperatures recorded in McAtee Creek near the stream's mouth during 1999.

A detailed habitat survey was conducted at stream mile 0.5, and 2.0 in McAtee Creek. At mile 0.5 the streambed was dominated by large gravel and cobble substrate (Table 2). Woody debris was moderately abundant and much of this debris extended across the channel. Spawning habitat was relatively abundant, but fine sediment appeared excessive in some areas. Instream and bank cover, and pool quality were rated good to excellent (Table 3). Throughout this sample section several small landslides contributed to poor bank instability, but overall streambank stability was moderate. Riparian habitats received moderate grazing by wildlife. At stream mile 2.0 large cobbles and boulders dominated the streambed (Table 2). Woody debris was relatively rare and spawning habitat was very limited. Instream cover and pool quality were very high, while streambank stability, bank cover, and use of riparian habitats was moderate (Table 3). Average wetted width ranged from 10.9 to 19.6 feet, and average water depth ranged from 7.2 to 8.5 inches.

Circle Creek

A reach survey was conducted in Circle Creek from its confluence with McAtee Creek upstream to the mouth of its first tributary (stream mile 0.75). Riffle habitats dominated the reach (62%), with pool and run habitats comprising a much lower percentage of the habitat types (Table 1).

A detailed habitat survey was conducted at mile 0.5 in Circle Creek. At stream mile 0.5 the streambed was dominated by boulder and cobble substrates (Table 2). Woody debris was relatively rare. Spawning habitat was limited because most of the suitable spawning gravel was blanketed with fine sediment. Instream cover was limited but bank cover was rated very high (Table 3). Pool quality was moderate, and riparian use was low. The average wetted width was 6.4 feet, and the average water depth was 4.6 inches at this site.

Gorge Creek

A reach survey was conducted in Gorge Creek from its mouth at McAtee Creek upstream to the waterfall. Of the three main habitat types (pool, riffle, run), riffle habitats dominated this reach (55%) and were made up of primarily high-gradient riffles. Pools, primarily in the form of plunge scour pools, were the next most abundant habitat type (39%)(Table 1).

A detailed habitat survey was conducted a half mile above the mouth of Gorge Creek. At stream mile 0.5 the streambed was dominated by cobble and boulder substrates (Table 2). Woody debris was extremely abundant and most of this debris extended across the channel. Spawning habitat was very limited, and may not be adequate to support a resident fish population. Instream and bank cover, and pool quality were all very high, bank stability was moderate, and use of riparian habitats was low (Table 3). The average wetted width was 10.3 feet, and the average water depth was 6.3 inches at this site.

Cougar Creek and Unnamed Tributary

Habitat data were not collected in Cougar or the unnamed tributary to McAtee Creek.

Fish distribution and Abundance

McAtee Creek

Rainbow trout were captured in McAtee Creek in all sample sections between the stream's mouth and the barrier falls just above stream mile 2.0 (Figure 4). No other fish species were observed. No fish were observed or captured in a 323 foot-long sample section at stream mile 2.25. This sample section was located above a set of two waterfalls that prohibit upstream movement of fish. The relative abundance of rainbow trout in McAtee Creek was generally high in sample sections where they were captured. Relative abundances ranged from 17 to 45 trout greater than 3 inches per 1000 feet of stream length (Figure 43).

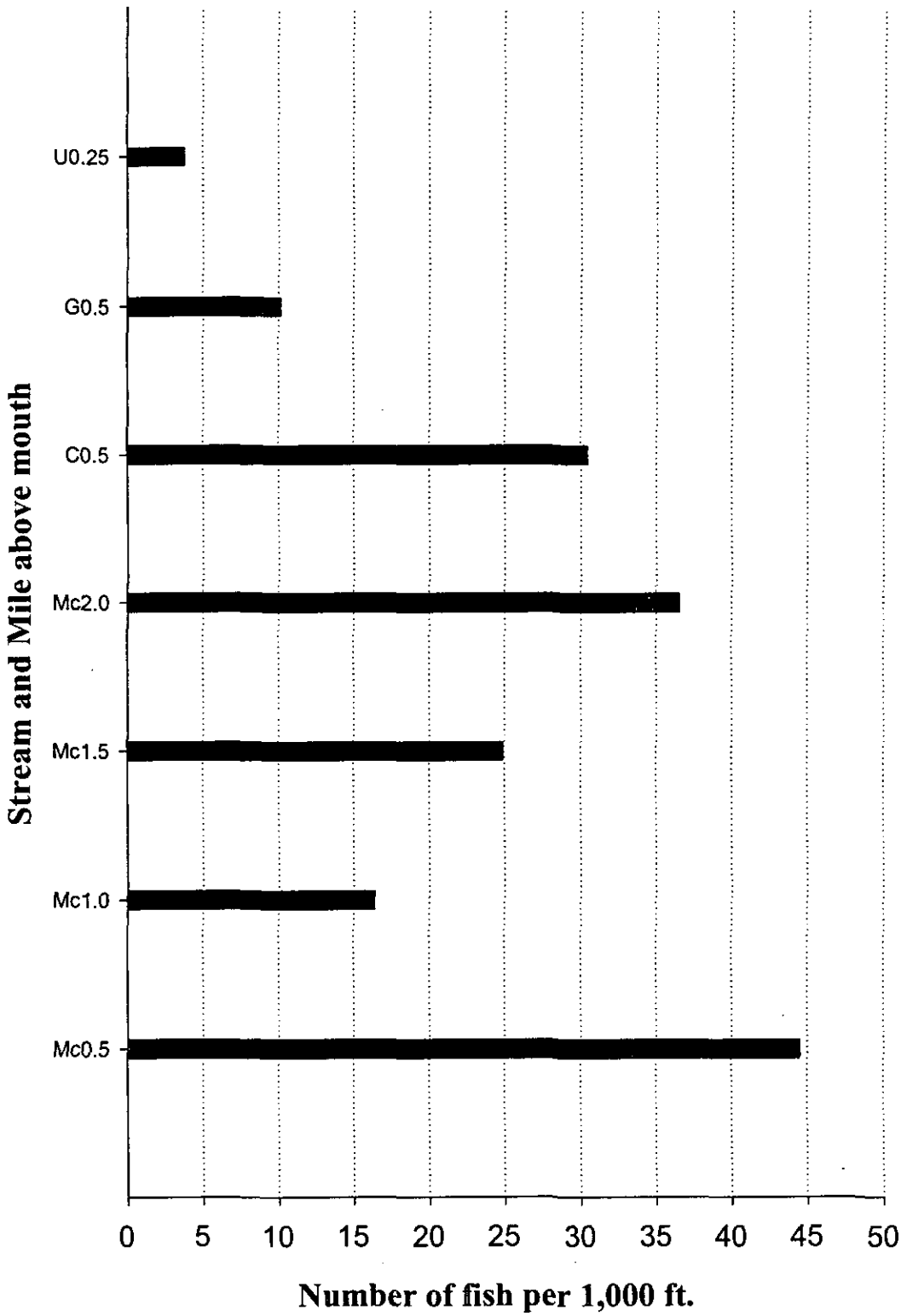

Figure 43. Catch of rainbow trout 3.0 inches and longer in main McAtee Creek (Mc and stream mile), Circle Creek (C and stream mile), Gorge Creek (G and stream mile), and an Unnamed Tributary to McAtee Creek (U and stream mile) during 1999.

A depletion population estimate was made in McAtee Creek at stream mile 0.5 and mile 2.0. At stream mile 0.5, a 427 foot-long sample section supported an estimated 21 rainbow trout (SE: 0.5), with 3 of these fish between 3 and 6 inches long and 18 (SE: 0.5) between 6 and 12 inches. This estimate translates to 49.2 rainbow trout greater than 3 inches per 1000 feet of stream (Figure 44). At stream mile 2.0, a 328 foot-long sample section supported 12 rainbow trout between 6 and 12 inches long, or 36.6 rainbow trout per 1000 feet of stream. All fish were captured on the first pass of a two-pass depletion population estimate.

Circle Creek

Rainbow trout were found in the lower portion of Circle Creek at stream mile 0.5. A depletion population estimate was made at this location. The 328 foot-long sample section supported an estimated 12 rainbow trout (SE: 0.7), with 6 of these fish (SE: 0.7) between 3 and 6 inches long, and 6 between 6 and 12 inches. This translates to an estimated 36 rainbow trout greater than 3 inches per 1,000 feet of stream length. Rainbow trout were observed at the mouth of the first unnamed tributary to Circle Creek (approximately 0.75 miles upstream from the mouth of Circle Creek), but no fish were captured at the next upstream sampling site (stream mile 1.0). It appeared that low flow above the first tributary limited the upstream fish distribution.

Gorge Creek

Rainbow trout were captured in Gorge Creek below the falls. A two-pass depletion estimate was attempted at stream mile 0.5 in Gorge Creek. However, no fish were captured on the second pass. The 394 foot-long sample section yielded only 4 rainbow trout. No fish were observed or captured in a 311 foot-long sample section above the waterfall at stream mile 1.0.

Unnamed tributary North of Gorge Creek

A single rainbow trout was captured in the unnamed tributary to McAtee Creek below the barrier waterfall (Figure 4). No fish were observed or captured in a 246 foot-long sample section above the waterfall.

Cougar Creek

Cougar Creek appeared to be too small to support a resident fish population. A single pass electrofishing effort was made above the falls (stream mile 0.5) and just above the stream's mouth. No fish were observed or captured in the 344 foot-long sample section at stream mile 0.5. Likewise, no fish were observed or captured in the 327 foot-long sample section at the mouth of Cougar Creek.

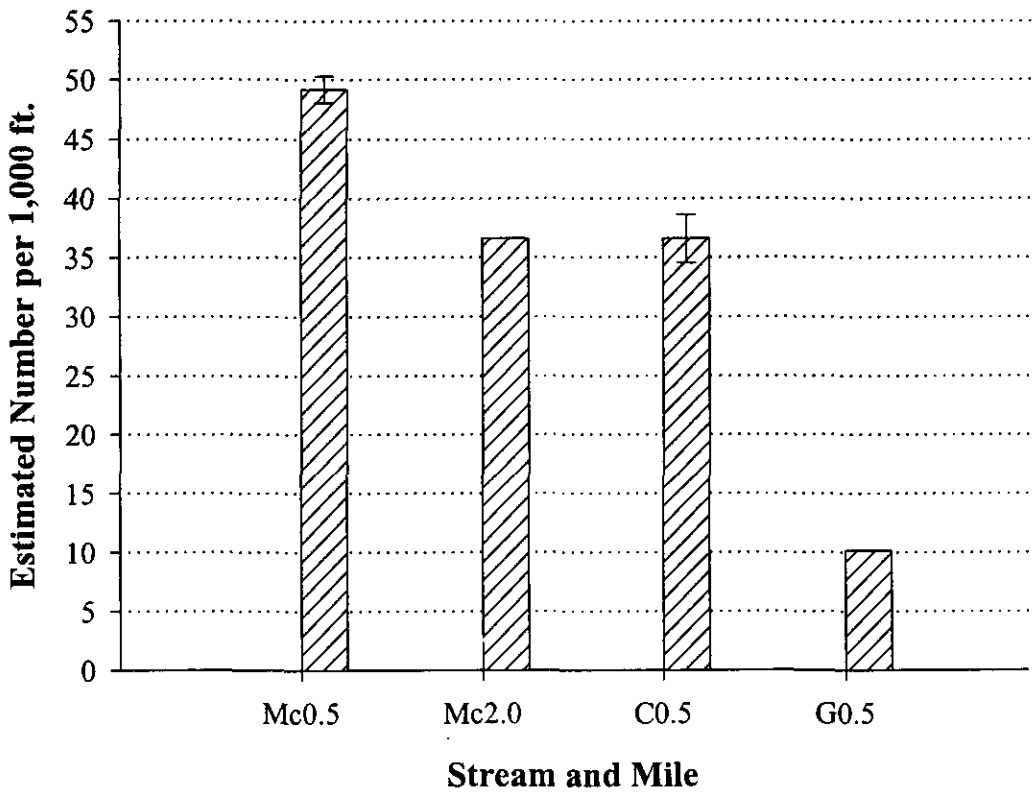

Figure 44. Estimated number rainbow trout 3.0 inches and longer in McAtee Creek (Mc), Circle Creek (C), and Gorge Creek (G) by stream mile. Vertical lines represent standard errors.

Fish Length and Weight

Rainbow trout captured in McAtee Creek ranged between 4.3 and 11.0 inches in length (Figure 45). Average lengths of captured rainbow trout were highest at stream mile 2.0, but average lengths showed no longitudinal trends. In Circle Creek, rainbow trout ranged from 4.3 to 8.3 inches long, with an average length of 6.1 inches. Rainbow trout in Gorge Creek were between 6.4 and 8 inches long, with an average length of 7.4 inches. The single rainbow trout captured in the unnamed tributary to McAtee Creek measured 6.1 inches long.

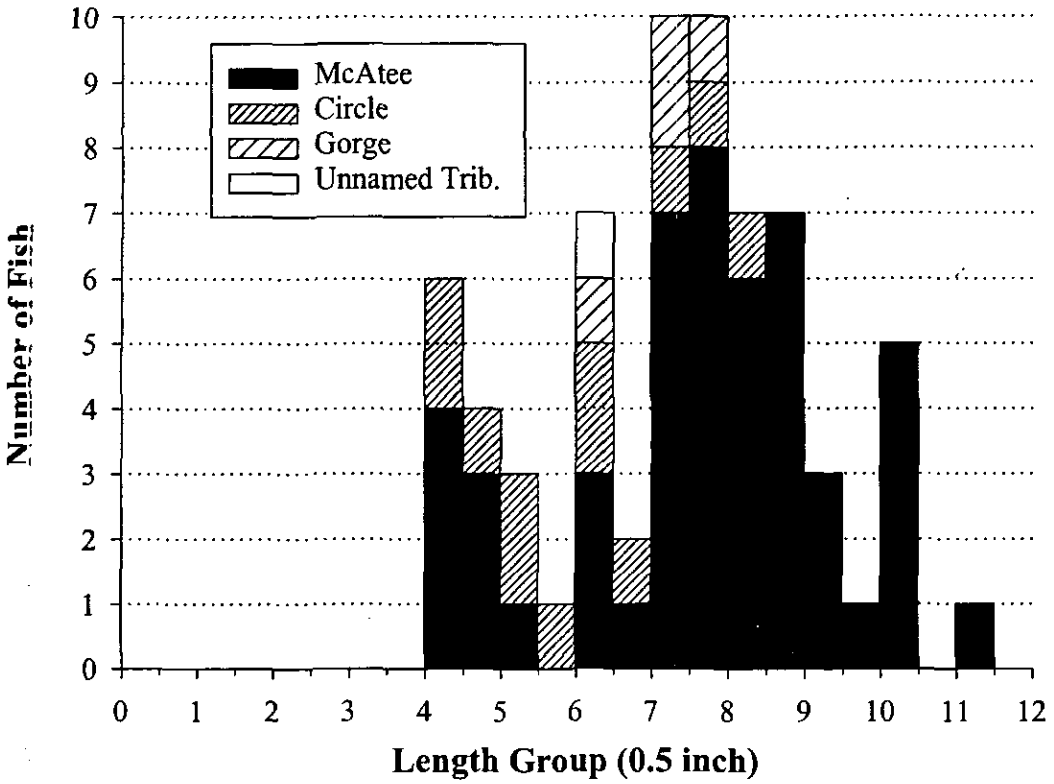

Figure 45. Length frequencies for rainbow trout captured in McAtee Creek, Circle Creek, Gorge Creek and an unnamed tributary to McAtee Creek during 1998.

Comparison to Previous Sampling

The distribution of rainbow trout we observed in the McAtee basin was similar to the distribution observed during sampling done in 1994 (J. Brammer, Montana FWP, Dillon, MT, files). During that survey, rainbow trout were captured below the waterfall in McAtee Creek by angling, and no fish were captured above this waterfall. Angling in Circle Creek captured rainbow trout ranging from 4 to 9 inches long. No fish were captured in Gorge Creek but the field crew reported observing fish in the unnamed tributary north of Gorge Creek.

Mill Creek

Mill Creek is a 6.5 mile-long tributary to Bear Creek draining the Madison Range. In its lower reaches, which flow through privately owned land, irrigation withdrawal and hyporheic flow dry the stream channel. Consequently, it is likely that the stream never reaches Bear Creek. Its upper reaches, which originate in the Lee Metcalf Wilderness Area, flow through coniferous forest interspersed with low gradient, grassy meadows. Single pass electrofishing efforts were made at stream miles 3.5 and 4.0. No fish were observed or captured in the 245 foot-long sample section at mile 3.5. Likewise, no fish were observed or captured in the 360 foot-long sample section at

mile 4.0. Based on this sampling, Mill Creek appears fishless. No habitat data were collected in Mill Creek.

Moose Creek

Moose Creek is an 8 mile-long tributary to the Madison River, originating in the Lee Metcalf Wilderness area. The creek drains Finger Lakes, a chain of small to moderately sized headwater lakes and seasonal ponds. From its source to stream mile 5.75 Moose Creek flows through conifer forest interspersed with small, open meadows. From stream mile 5.75 downstream to its mouth Moose Creek flows through private land with riparian areas of mixed conifer and deciduous forests interspersed with dense willow thickets. An artificial migration barrier exists approximately one-third of a mile above the mouth of Moose Creek. At stream mile 2.5 a small, adjustable weir may also prevent upstream fish movement depending on levels of stream discharge and the number of boards placed in the weir. However, fish are currently distributed above and below both of these barriers (see below). Bad Luck Creek and two unnamed tributaries enter Moose Creek downstream from the Forest Service boundary. Bad Luck Creek enters Moose Creek from the north at stream mile 1.75. As Bad Luck Creek leaves the Madison Range and enters the valley bottom, the creek encounters a large alluvial bench and loses surface flow until reemerging in a wetland near its mouth. The first unnamed tributary enters Moose Creek from the north at stream mile 1.4. This small stream originates in a dense willow bog located 0.75 to 1.0 miles above the stream's mouth. The second unnamed tributary to Moose Creek enters from the south approximately 2.4 stream miles from the mouth of Moose Creek. This tributary drains a small impoundment located approximately 0.75 miles upstream from its mouth. After leaving the impoundment, the stream flows through mixed stands of conifers, willow and aspen. The two unnamed tributaries are the only tributaries to Moose Creek that support fish populations.

The Montana FWP fish planting database indicates that 11,500 unidentified cutthroat trout were planted in Moose Creek on 8/21/32 near the stream's mouth. Additionally, 13,348 brown trout were planted on 7/22/47 and 5,000 rainbow trout were planted in Moose Creek on 8/18/50 at the same location.

Habitat

During the summer of 1998, stream temperature was measured at the mouth of Moose Creek using an Onset Optic Stowaway® thermograph (Figure 3). Mean stream temperature from July 13 to October 9 was 51.6°F (Figure 46). The maximum stream temperature during this period was 62.4°F. Stream temperatures fluctuate 2.9 to 14.4°F daily. Stream temperatures were also measured from July 7 through September 26, 1999 in Moose Creek at the stream's mouth and at stream miles 2.0, 3.75, 5.5, and 7.25 using Onset Optic Stowaway® thermographs (Figure 3). Mean summer temperatures remained relatively cool, ranging from 42.3°F at stream mile 5.5 to 50.8°F at the mouth of Moose Creek (Figure 47). Stream temperatures fluctuated 1.4 to 15.9°F daily. Maximum summer temperatures never exceeded 63.0°F.

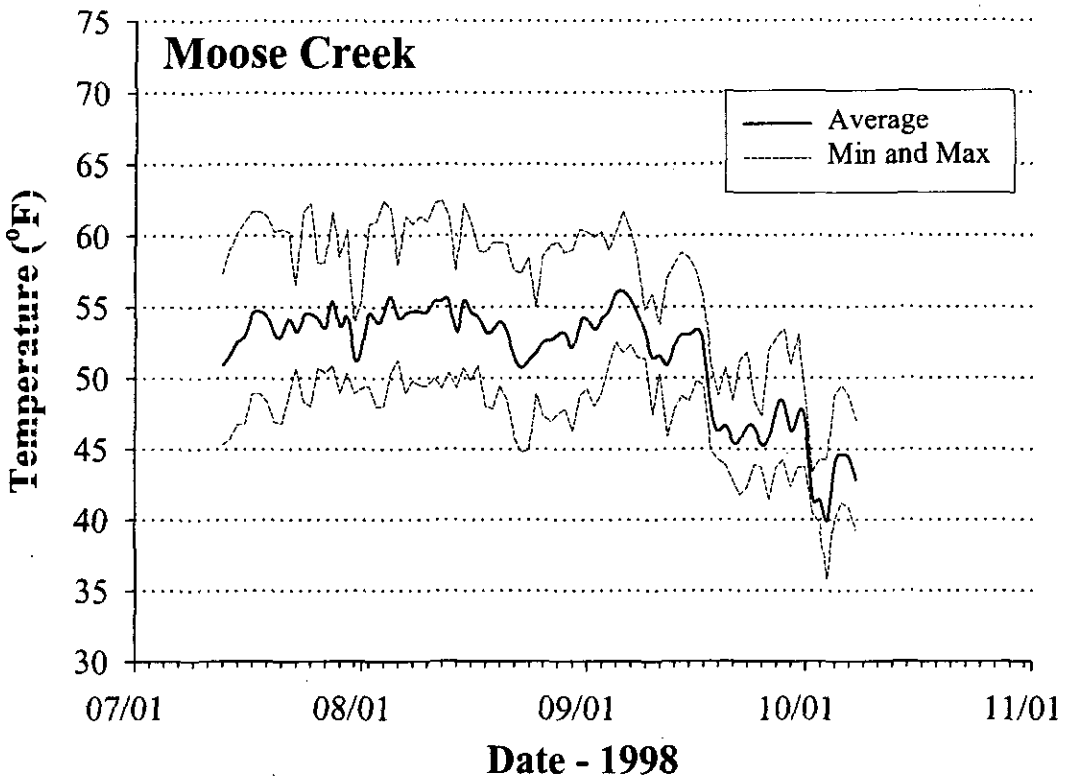

Figure 46. Average, minimum, and maximum stream temperatures in Moose Creek near the stream's mouth during 1998.

Moose Creek

Detailed habitat surveys were conducted in Moose Creek at stream miles 0.25, 2.0, and 7.25. At stream mile 0.25 the streambed was predominated by large and small gravel (Table 2). Woody debris was moderately abundant. Spawning habitat was limited but probably adequate. Instream and bank cover, and bank stability ratings were high. Pool quality was moderate, and there were no signs of riparian use (Table 3). At stream mile 2.0 the streambed was dominated by small and large gravel and cobble (Table 2). Woody debris was moderately abundant and much of this debris extended across the stream channel. Spawning habitat was excellent. Instream and bank cover, and bank stability ratings were high. Pool quality was moderate, and there were no signs of riparian use (Table 3). At stream mile 7.25 the streambed was almost entirely composed of small gravels in riffle habitats and silt in runs (Table 2). The abundance of woody debris was relatively low and none of this debris extended across the stream channel. Spawning habitat was excellent. Instream cover ratings were relatively low due to the lack of woody debris and boulders. However, bank cover and bank stability ratings were high (Table 3). The sample section lacked clearly defined pools but deep, low velocity runs provided habitat conditions similar to those in high quality pools. Browsing of the riparian habitat by wildlife was moderate.

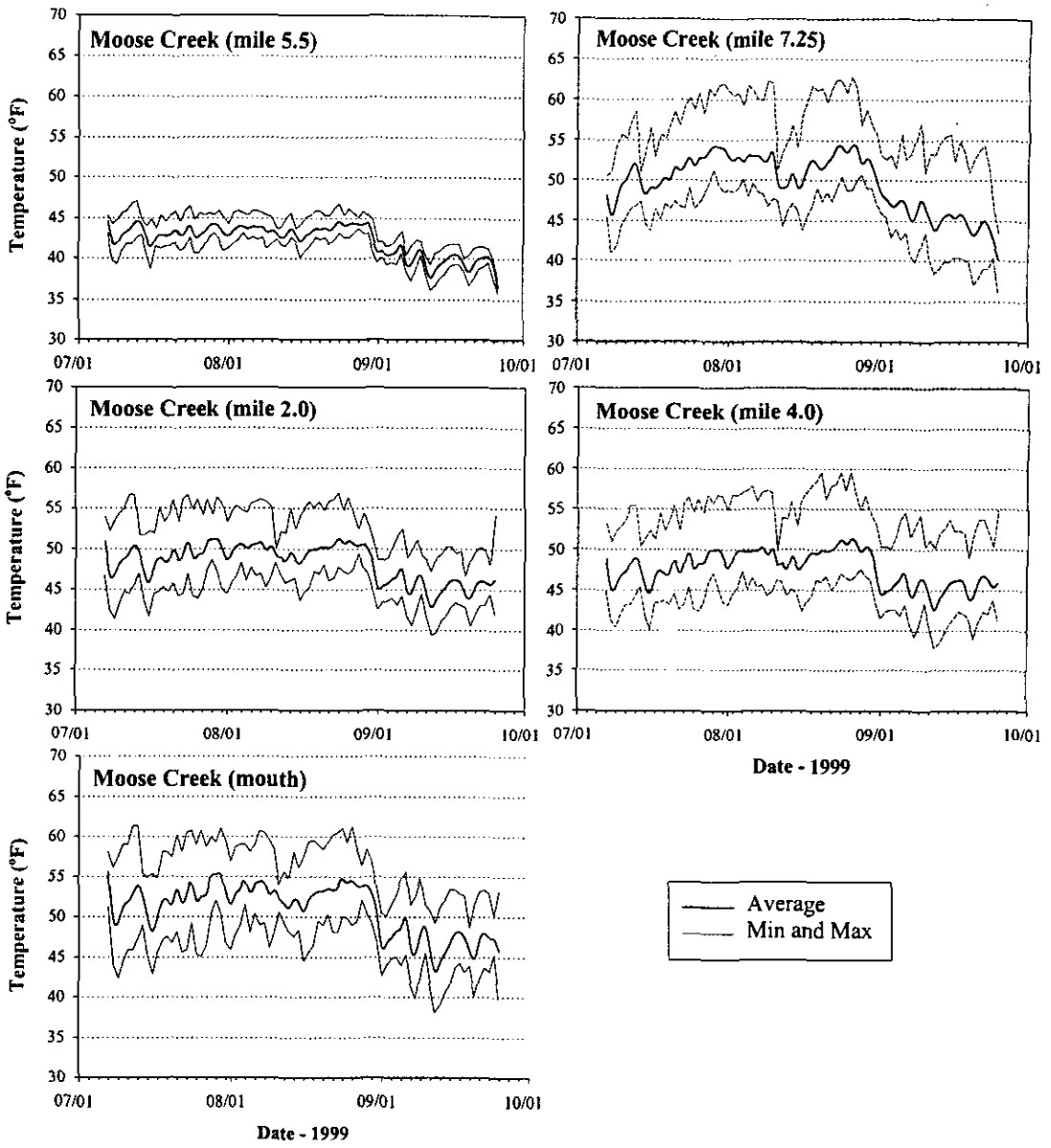

Figure 47. Average, minimum, and maximum stream temperatures at five locations in Moose Creek during 1999.

Bad Luck Creek and unnamed tributaries

Habitat data were not collected in Bad Luck Creek, or the unnamed tributaries.

Fish Distribution and Abundance

Moose Creek

Brown trout and Yellowstone cutthroat trout were the only fish species captured in Moose Creek. Brown trout were found in Moose Creek from the lowest sample section at stream mile 0.25 upstream through stream mile 3.25 (Figure 48). Yellowstone cutthroat trout were found in

Moose Creek at stream miles 6.75 and 7.25. No fish were observed or captured in sample sections at stream miles 3.75, 4.25, 4.75, 5.75, and 6.25. No physical barriers to fish movement were observed above the upstream distribution of brown trout or below the downstream distribution of Yellowstone cutthroat trout.

Relative abundances of brown trout were relatively high in the lower 1.75 miles of stream, ranging from 83.8 to 198.2 trout greater than 3 inches per 1000 feet of stream. Above this point relative abundances dropped dramatically (Figure 48). The relative abundance of Yellowstone cutthroat trout was 108.9 trout greater than 3 inches per 1000 feet of stream at mile 7.25 (Figure 48). This was the first sample section below the Finger Lake chain, which until recently was stocked with Yellowstone cutthroat trout. Yellowstone cutthroat trout appear to have successfully colonized Moose Creek below the headwater lakes. However, densities of Yellowstone cutthroat trout decline rapidly downstream from Finger Lake. For example, a 295 foot-long sample section at stream mile 6.75 yielded only two Yellowstone cutthroat trout and was the lowest sample section where Yellowstone cutthroat trout were captured.

Depletion population estimates were made in Moose Creek at stream miles 0.25, 2.25, and 7.25. At stream mile 0.25, a 393 foot-long sample section supported an estimated 60 brown trout 3 inches and longer (SE: 2.9) or approximately 152 trout per 1,000 feet of stream length (Figure 49; Appendix E). At stream mile 2.5, a 308 foot-long sample section supported an estimated 16 brown trout 3 inches and longer (SE: 2.1) or approximately 52 trout per 1,000 feet of stream (Figure 49). At stream mile 7.25, a 459 foot-long sample section supported an estimated 65 Yellowstone cutthroat, with 11 (SE: 1.1) between 3 and 6 inches long and 52 (SE: 1.9) between 6 and 12 inches long. This estimate translates into approximately 141 Yellowstone cutthroat trout 3 inches and longer per 1,000 feet of stream (Figure 49).

Unnamed tributary #1

At stream mile 0.25, a 246 foot-long electrofishing sample section yielded 7 brown trout in the first unnamed tributary to Moose Creek. The relative abundance was 20.2 brown trout greater than 3 inches per 1000 feet of stream (Figure 48).

Unnamed tributary #2

At stream mile 0.5, a 279 foot-long sample section yielded 19 brown trout in the second unnamed tributary to Moose Creek. The relative abundance was 60.9 brown trout greater than 3 inches per 1000 feet of stream length (Figure 48).

Bad Luck Creek

At mile 2.5, a single pass electrofishing effort was made in Bad Luck Creek. No fish were observed or captured in the 230 foot-long sample section. Based on this sampling, Bad Luck Creek appears fishless.

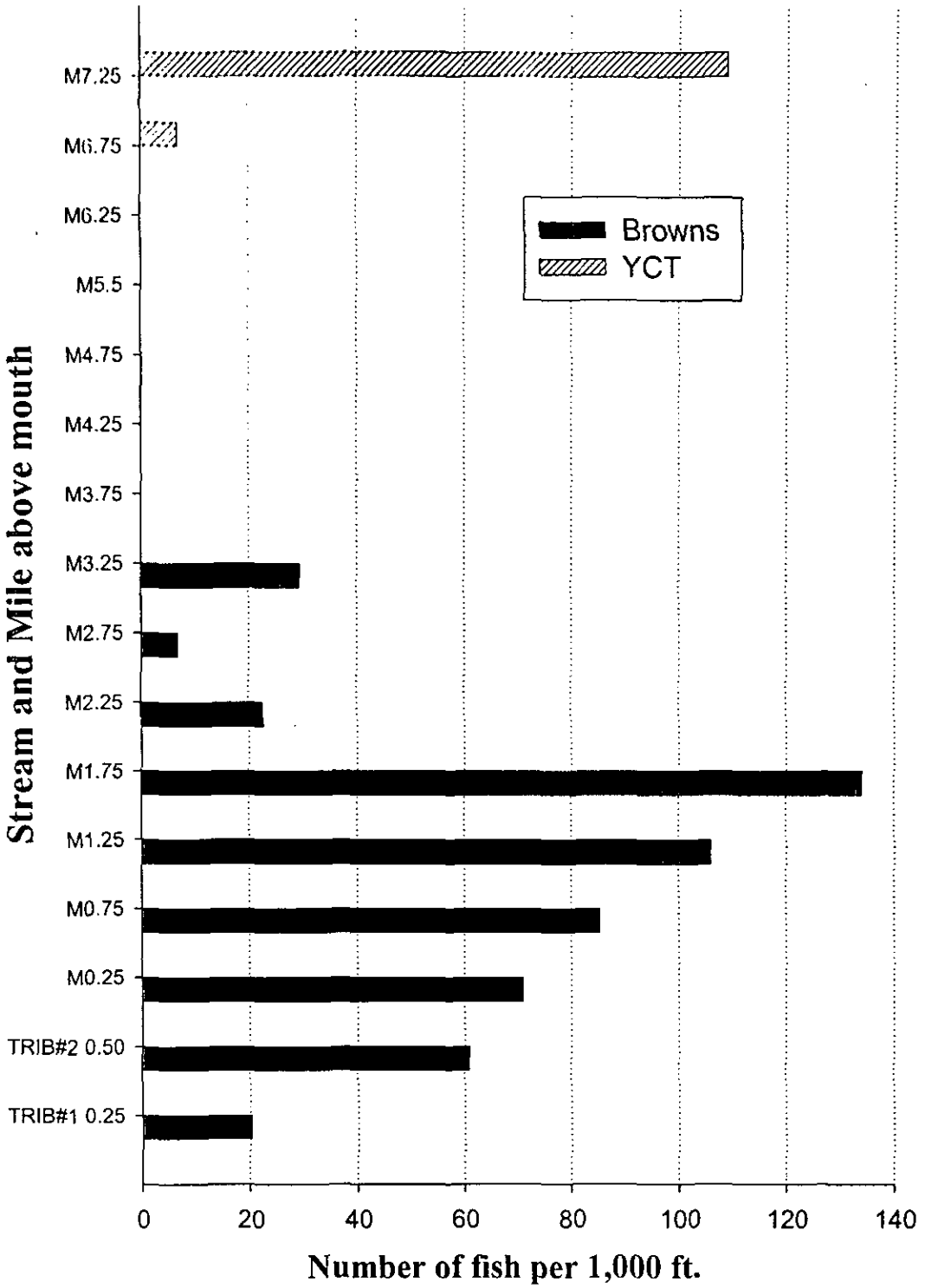

Figure 48. Catch of brown trout and Yellowstone cutthroat trout (YCT) captured in Moose Creek (M and stream mile), the first unnamed tributary (TRIB#1) and the second unnamed tributary (TRIB2). All sites shown on y-axis were sampled and zero values indicate no fish were captured.

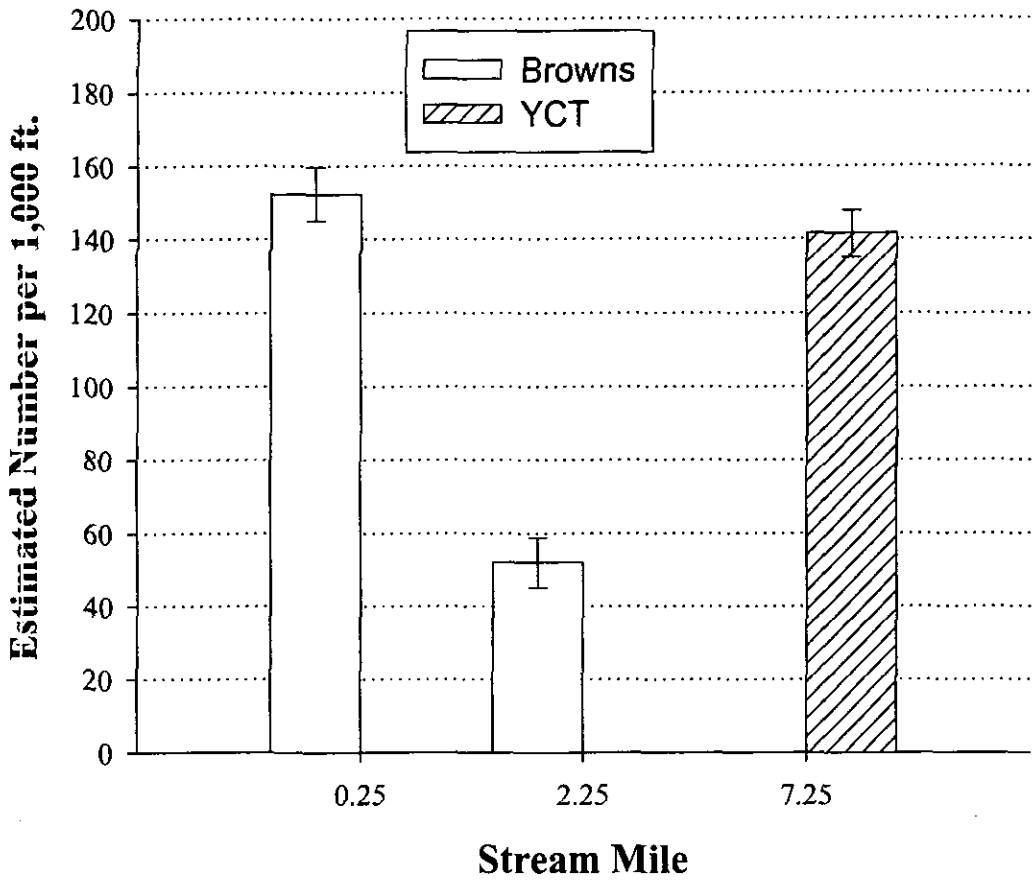

Figure 49. Estimated number of brown trout and Yellowstone cutthroat trout (YCT) 3.0 inches and longer in Moose Creek by stream mile. Vertical lines represent standard errors.

Fish Length and Weight

Brown trout captured in Moose Creek varied between 1.0 and 11.2 inches in length. Average lengths of captured brown trout were similar in the lowest four sample sections and increased slightly in the remaining upstream sample sections where brown trout were found (Appendix F). Yellowstone cutthroat trout captured in Moose Creek varied between 3.7 and 9.4 inches in length with an average length of 6.9 inches (Figure 50). Brown trout captured in the first unnamed tributary to Moose Creek ranged from 1.8 to 9.7 inches long, with an average length of 5.5 inches (Figure 51). In the second unnamed tributary to Moose Creek a 16.7 inch-long brown trout was captured just below the impoundment. The fish was in poor condition, indicating that it had escaped from the impoundment and was having difficulty meeting its energy demands in the small stream. The remaining brown trout ranged from 2 to 10.5 inches long, with an average length of 5.9 inches.

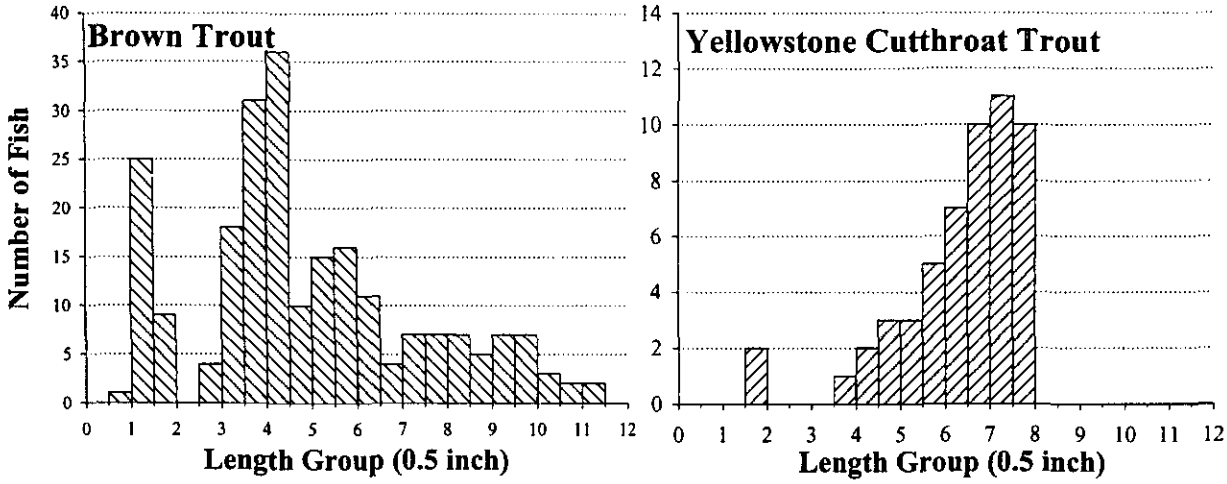

Figure 50. Length frequencies of brown trout (left) and Yellowstone cutthroat trout (right) captured in Moose Creek in 1999.

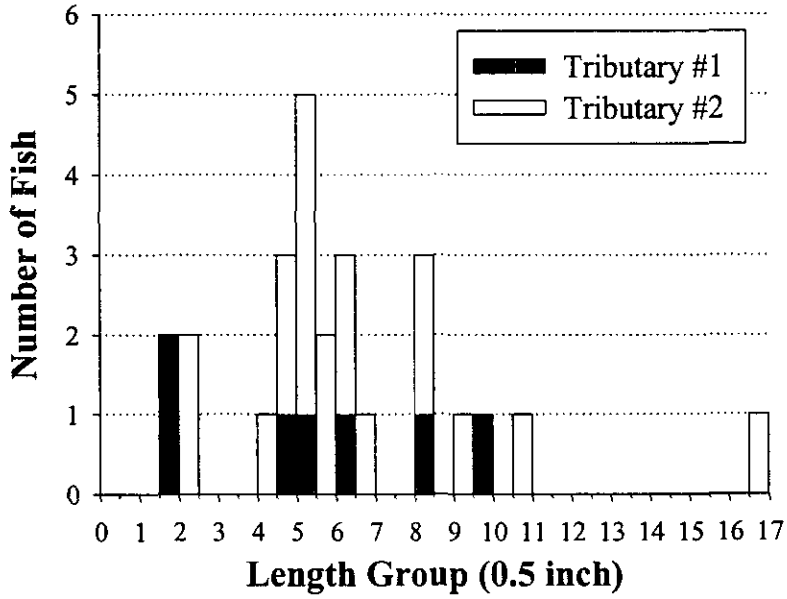

Figure 51. Length frequencies of brown trout captured in two unnamed tributaries to Moose Creek during 1999.

Comparison to Previous Sampling

A previous inventory of Moose Creek upstream from the Forest Service boundary found no fish in a 350 foot-long sample section at stream mile 5.5 and captured 19 Yellowstone cutthroat trout in a 370 foot-long sample section at stream mile 7.0. This translates into an estimated 52 Yellowstone cutthroat trout greater than 3 inches long per 1000 feet of stream (J. Brammer,

Montana FWP, Dillon, files). We found significantly higher numbers of Yellowstone cutthroat trout during our sampling at stream mile 7.25 (Figure 49). However, since trout densities were highly variable in Moose Creek differences in our findings may be a result of slightly different sampling locations.

Morgan Gulch

Morgan Gulch had no stream flow when checked several times below and above the Forest Service boundary in the summer of 1997 and 1998.

Nickerson Creek

No fish were observed or captured during sampling of Nickerson Creek at stream miles 1.9 (360 foot-long section) and 2.1 (an approximately 150 foot-long section of spot-checking). In addition, no fish were seen in its major tributary at stream mile 0.1 (an approximately 150 foot-long section of spot-checking). Previous sampling of a 495 foot-long section in Nickerson Creek on July 7, 1995 near stream mile 1.8 also did not find any fish (J. Brammer, Montana FWP, Dillon, MT, files). Based on these samplings Nickerson Creek appears to be fishless.

No Man Creek

No Man Creek is a 6.0 mile-long tributary to Indian Creek, originating and flowing entirely through the Lee Metcalf Wilderness Area (Figure 1). For most of its length, the stream flows through a narrow canyon in which several large waterfalls are present. A waterfall is present 500 feet upstream from the mouth of No Man Creek, resulting in a 35 foot drop in the stream channel. A 12 foot-high waterfall is present at stream mile 0.5. Waterfalls preventing upstream fish movement are also present at stream miles 0.8 (60 foot drop), 1.8 (12 ft), 2.0 (20 ft), 2.1(6 ft), and 4.25 (50 ft). No Man Lake and several small, unnamed headwater lakes are located within the No Man Creek drainage. Yellowstone cutthroat trout have been stocked in No Man Lake, and were last planted in 1993 (P. Clancey, Montana FWP, Bozeman, files; Appendix G); however, no records exist indicating No Man Creek has ever been stocked. This lake is most likely the source of the Yellowstone cutthroat population in No Man Creek. No Man Creek does not drain No Man Lake directly but is connected to this via a small tributary. A landslide has buried most of the 0.75 mile-long stream connecting No Man Lake with No Man Creek; except for the first 500 feet upstream from its mouth, the lower 0.5 miles of stream channel are subterranean. While the No Man Lake outlet stream is incapable of supporting a resident fish population at summer flows, fish may be flushed from No Man Lake into No Man Creek during years of heavy spring runoff.

Habitat

An Onset Optic Stowaway® thermograph was placed in No Man Creek near the stream's mouth on July 9 and left to record stream temperatures until September 27, 1999 (Figure 3). Mean stream temperature for this period remained cool at 44.8°F. Stream temperatures fluctuated from 1.4 to 10.3°F daily. The maximum recorded stream temperature was 51.4°F (Figure 52).

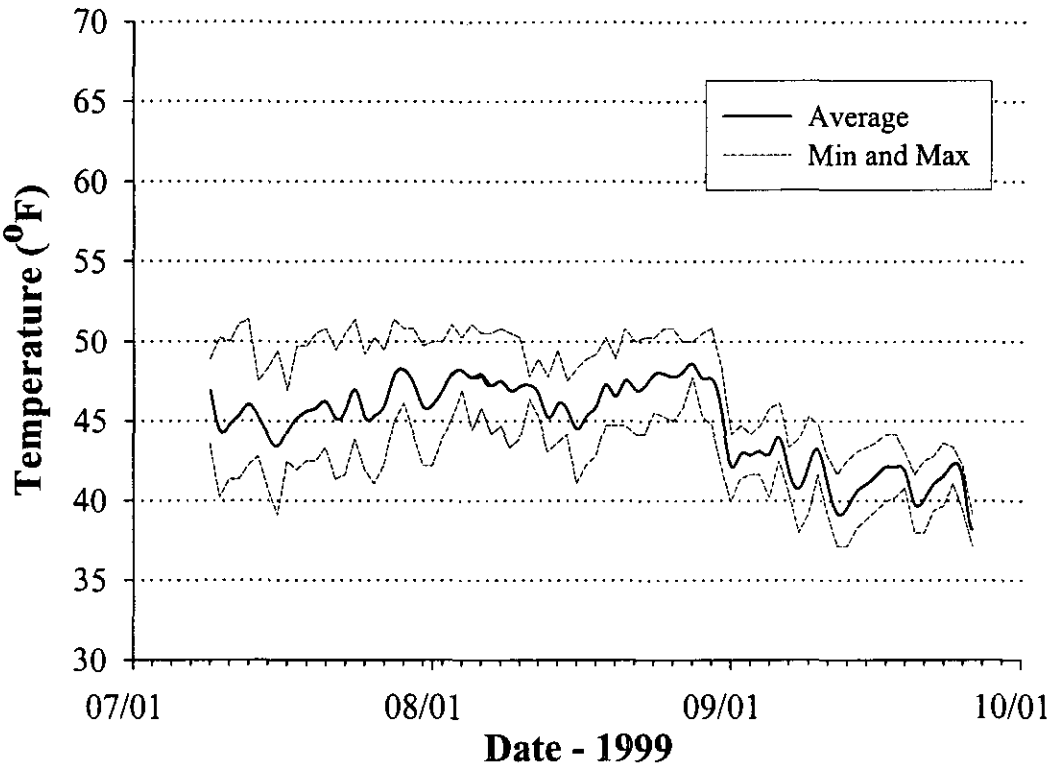

Figure 52. Average, minimum, and maximum stream temperatures in No Man Creek near the stream's mouth during 1999.

A reach survey was conducted in No Man Creek from its mouth at Indian Creek, upstream approximately 4.25 miles. Riffle and pool habitat types dominated this reach, comprising nearly equal proportions of the stream channel (Table 1). High gradient riffles dominated riffle types, while plunge scour pool dominated pool types.

A detailed habitat survey was conducted in No Man Creek at stream miles 2.5, and 4.0. At stream mile 2.5 the streambed was dominated by large gravel and cobble (Table 2). Woody debris and spawning habitat were relatively abundant. Instream and bank cover, bank stability, and pool quality were all high, and use of riparian habitats was low (Table 3). At stream mile 4.0, the streambed was dominated by large gravel and cobble (Table 2). Woody debris was moderately abundant, but relatively little of this debris extended across the channel. Spawning habitat was limited, but probably adequate. Instream and bank cover, bank stability, and pool quality were all high, and use of riparian habitats was low (Table 3). The average wetted width ranged from 13.6 to 16.4 feet, and the average water depth ranged from 7.3 to 9 inches.

Fish Distribution and Abundance

Yellowstone cutthroat trout were found in No Man Creek at stream miles 0.5, 1.5, 2.5, 3.0, 3.5, and 4.0. No other fish species were present. No fish were observed or captured in sample sections at stream miles 1.0, 2.0, and 4.5. Yellowstone cutthroat trout were absent or present in very low densities in the first 2.5 miles of stream. The occurrence of several impassable waterfalls in this section of stream and the long distance from the upstream colonizing source of No Man Lake may explain this distribution pattern. Relative abundances of Yellowstone cutthroat trout were inconsistent among sample sections (Figure 53). A waterfall present at stream mile 4.25 resulting in a 50 foot drop in the stream channel represented the first barrier to upstream fish movement above the No Man Lake outlet (Figure 4). A single pass electrofishing effort was made above this barrier at stream mile 4.5. No fish were observed or captured in the 901 foot-long sample section.

Depletion population estimates were made in No Man Creek at stream miles 2.5 and 4.0. At stream mile 2.5, two electrofishing passes in a 328 foot-long sample section yielded only one Yellowstone cutthroat trout measuring 7.7 inches. At stream mile 4.0, a 394 foot-long sample section supported an estimated 6 Yellowstone cutthroat trout (SE: 0.5), with 5 of these fish (SE: 0.5) between 6 inches and 12 inches long, and 1 fish between 12 and 18 inches long (Figure 54; Appendix E). This estimate translates to 18.3 Yellowstone cutthroat trout greater than 3 inches long per 1000 feet of stream.

Fish Length and Weight

Yellowstone cutthroat trout captured in No Man Creek ranged from 5.8 to 14.6 inches long with an average length of 10.9 inches (Figure 55).

Comparison to Previous Sampling

There are no records of previous sampling for No Man Creek from the MRIS, nor from catalogued reports.

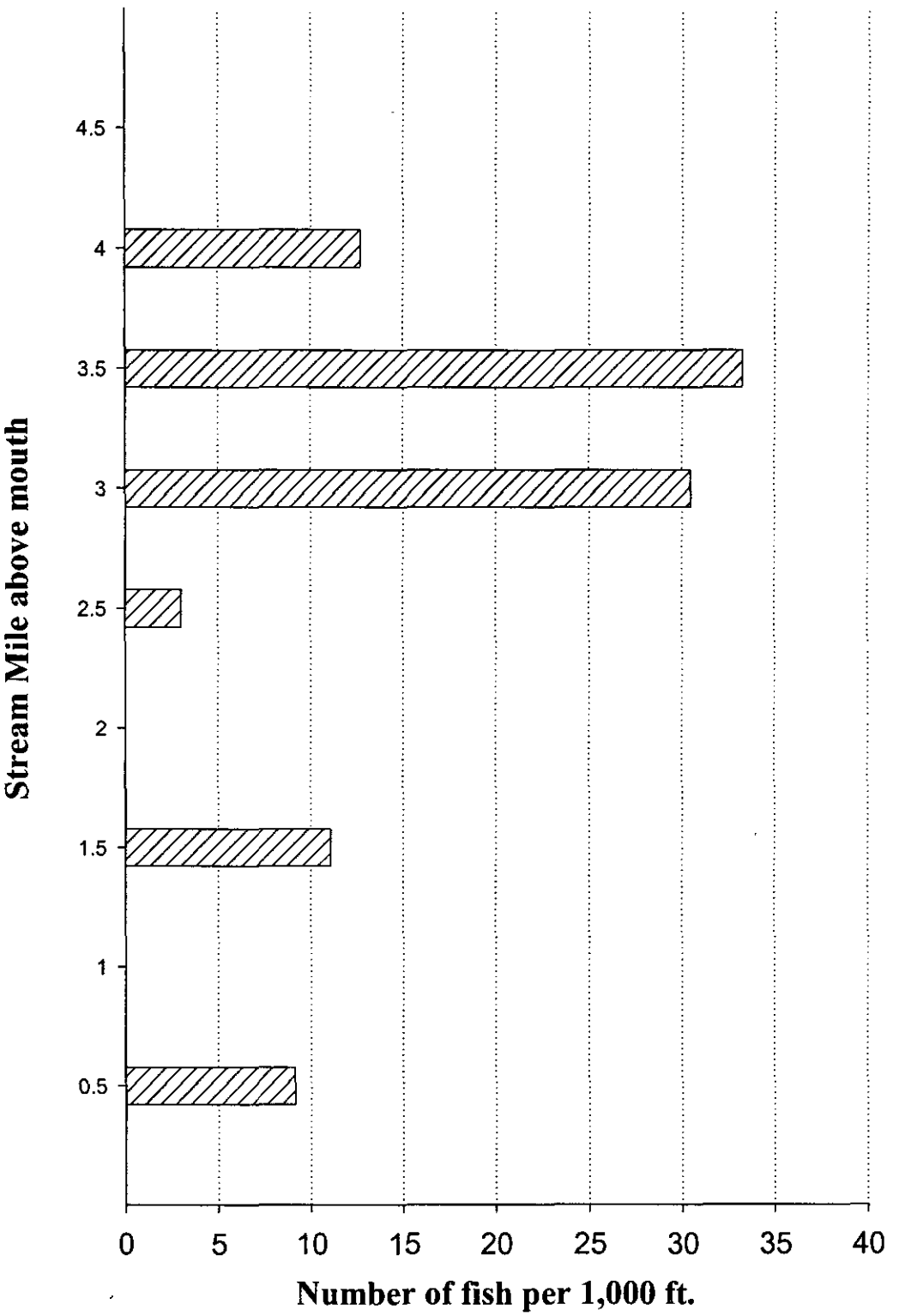

Figure 53. Catch of Yellowstone cutthroat trout captured in No Man Creek during 1998. All sites shown on y-axis were sampled and zero values indicate no fish were captured.

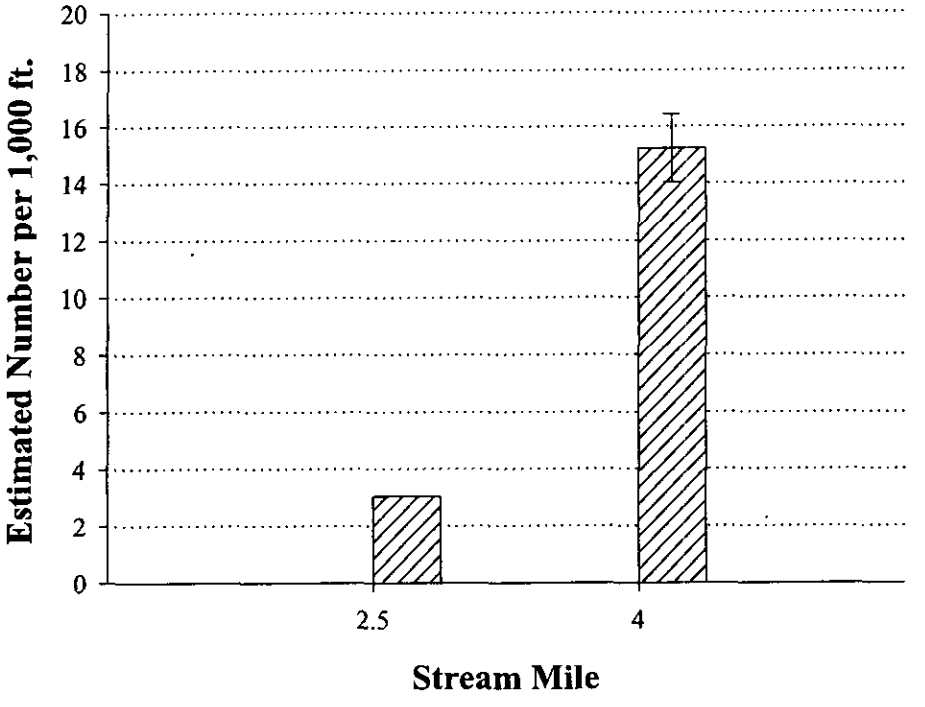

Figure 54. Estimated number of Yellowstone cutthroat greater than 3 inches long in No Man Creek by stream mile. Vertical lines represent standard errors.

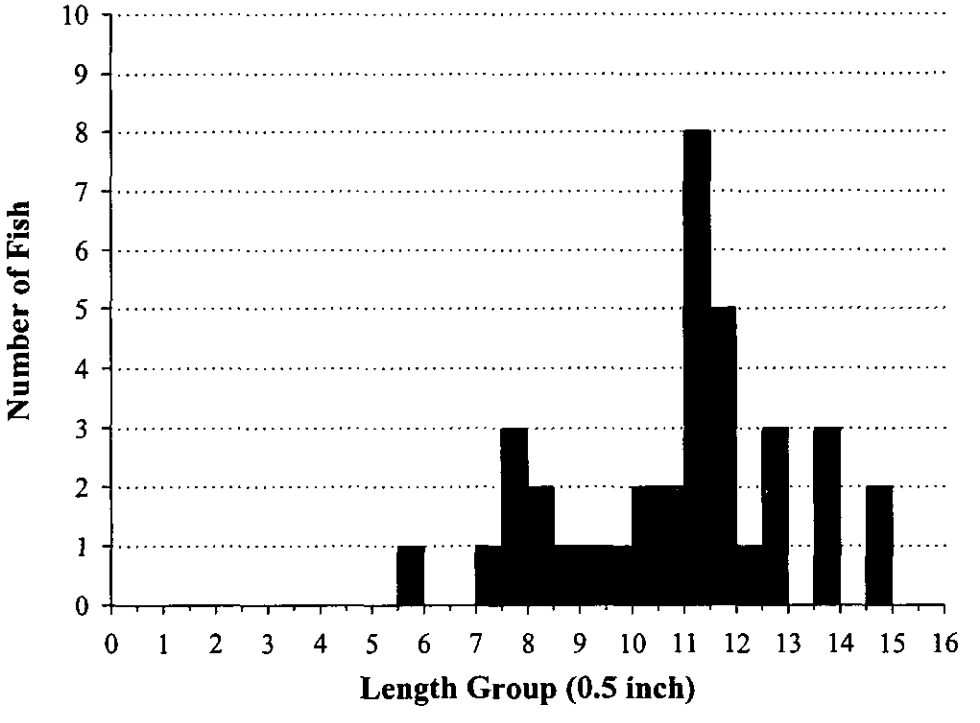

Figure 55. Length frequencies of Yellowstone cutthroat trout captured in No Man Creek during 1998.

Papoose Creek

Papoose Creek is an 8 mile-long stream draining the Madison Range and entering the Madison River from the east just north of Kirby Bridge (Figure 1). Cradle Lake and several smaller lakes and seasonal ponds are the headwaters for Papoose Creek. After leaving the Cradle Lake chain, Papoose Creek flows through alpine meadows before entering a steep canyon at stream mile 6.25. After emerging from the canyon, Papoose Creek flows through dense conifer forest until it reaches the Madison River. From stream mile 4.25 to 4.75 the channel gradient increases dramatically. We observed several cascades and small falls up to 6 feet in height within this reach that may prevent fish upstream fish movement. One tributary (previously unnamed but termed Nowhere Creek in this report) enters Papoose Creek at stream mile 5.75 after flowing approximately 1.5 miles through high elevation conifer forest. Just above the mouth of Nowhere Creek we also observed a 6 foot-high barrier falls in Papoose Creek (Figure 4). Additionally, a 30 foot-high waterfall is located at 6.3 miles above the mouth of Papoose Creek.

The Montana FWP fish planting database indicates that 8,800 unidentified cutthroat trout were planted on 8/28/31 near the mouth of Papoose Creek (Appendix G). Cradle Lake (referred to as both Cradle and Papoose Lake in Appendix G) has also received regular fish plantings. Cradle Lake was last planted with Yellowstone cutthroat trout on 8/13/93.

Habitat

Papoose Creek

An Onset Optic Stowaway® thermograph was placed in Papoose Creek near the stream's mouth on June 6 and left to record stream temperatures until October 20, 1998 (Figure 3). Stream temperatures remained relatively cold with a mean stream temperature of 46.3°F. Maximum stream temperatures never exceeded 55°F (Figure 56). Stream temperatures fluctuated 1.4 to 9.4°F daily. Stream temperature was also measured from July 1 through September 24, 1999 in Papoose Creek at the stream's mouth, and at stream miles 2.0, 4.0, and 6.0 using Onset Optic Stowaway® thermographs (Figure 3). Mean, and maximum stream temperature decreased in an upstream direction (Figure 57). Mean summer temperatures ranged from 38.4°F at stream mile 6.0 to 46.9°F at the stream's mouth. Maximum summer temperatures ranged from 42.3°F at stream mile 6.0 to 46.9°F at the stream's mouth. Stream temperatures fluctuated from <1.0 to 0.6°F degrees daily.

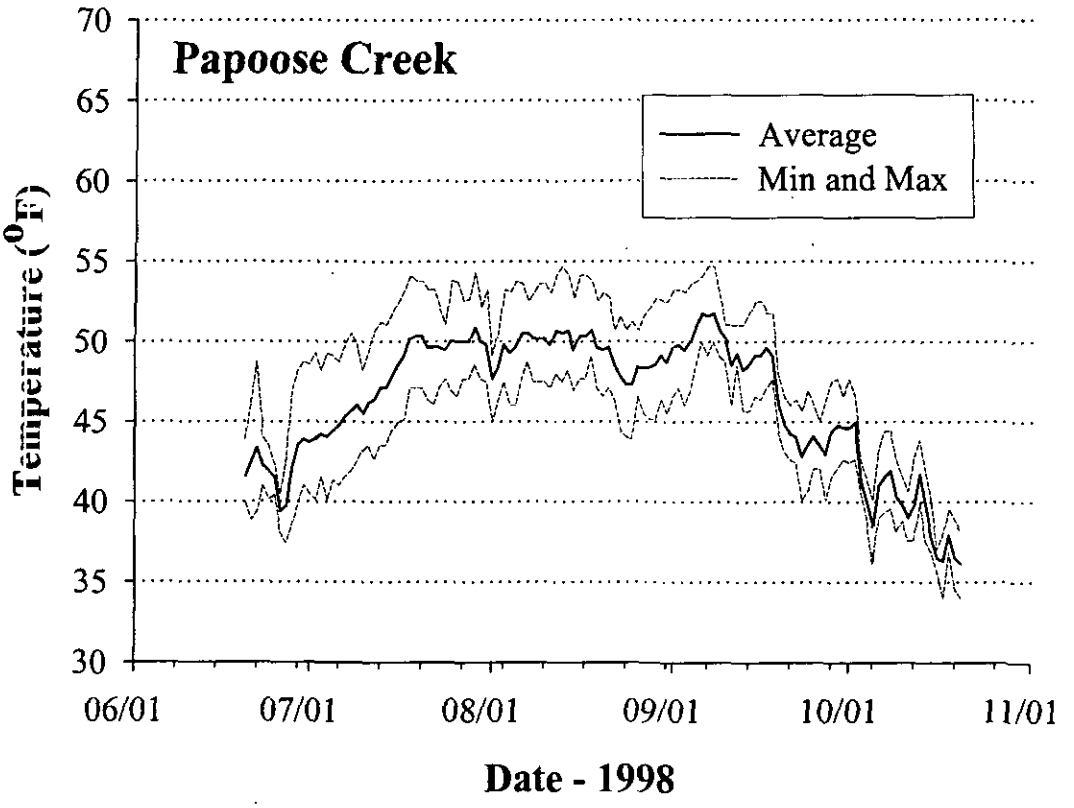

Figure 56. Average, minimum, and maximum stream temperatures in Papoose Creek near the stream's mouth during 1998.

Detailed habitat surveys were conducted in Papoose Creek at stream miles 0.5 and 3.0. At stream mile 0.5 the streambed was dominated by large and small gravels (Table 2). Woody debris and spawning habitat were abundant. Instream cover, bank cover, bank stability, and pool habitat ratings were all high (Table 3). Riparian use was moderate, with the only impacts coming from the landowner's front lawn that extends to the stream bank. At stream mile 3.0 the streambed was dominated by cobble (Table 2). Woody debris and spawning habitat were relatively abundant. Bank cover and bank stability were moderate, as were instream cover and pool quality (Table 3). Riparian habitat was heavily damaged by livestock. Average wetted stream widths ranged from 15.3 to 13.6 feet, and average water depths ranged between12.9 to 11.7 inches at these sample sites.

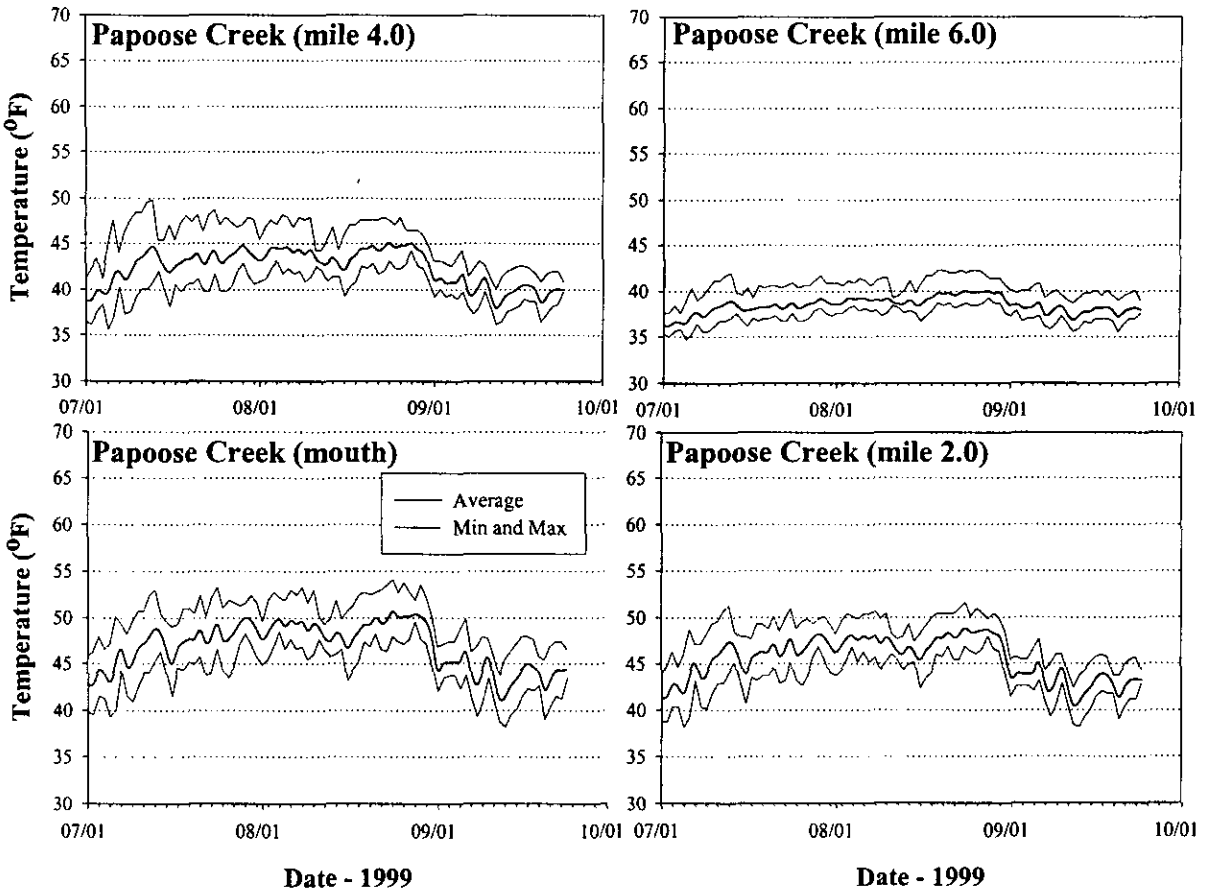

Figure 57. Average, minimum, and maximum stream temperatures at four locations in Papoose Creek during 1999.

Nowhere Creek

Habitat data were not collected for Nowhere Creek because it was fishless.

Fish Distribution and Abundance

Papoose Creek

In 1997, preliminary sampling was conducted in Papoose Creek. During this survey, Yellowstone cutthroat trout, brown trout, rainbow trout, and rainbow-cutthroat trout hybrids were captured (Figure 58). Yellowstone cutthroat trout were captured in sample sections at stream miles 1.5 and 2.0. Hybrids between rainbow trout and cutthroat trout were captured at stream mile 1.0. Rainbow trout were captured in sample sections at stream miles 0.5 and 1.0. Brown trout were captured at stream mile 1.5. No fish were captured in sample sections 3.5, 4.0, and 4.5 miles above the mouth of Papoose Creek. Papoose Creek was not sampled 3.0 miles above its mouth during this inventory.

Papoose Creek was more intensively sampled during the summer of 1999. Westslope cutthroat trout, brown trout, rainbow trout, and rainbow-westslope cutthroat trout hybrids were found in Papoose Creek during this inventory. Brown trout were found in all sample sections from stream mile 0.5 upstream to stream mile 2.0. Westslope cutthroat trout were found in all sample sections from stream mile 0.5 upstream to stream mile 3.5. No fish were captured in sample sections at stream miles 4.0, 4.5, 5.0, 5.75, and 6.5. Relative abundances of brown trout varied widely between sample sections, ranging from 3.1 to 27.0 trout greater than 3 inches per 1000 feet of stream length. Relative abundances of westlope cutthroat trout were generally low, ranging from a low 2.7 to 21.3 trout greater than 3 inches per 1,000 feet of stream.

During 1999, depletion population estimates were made in Papoose Creek at stream miles 0.5 and 3.0. At stream mile 0.5 a 407 foot-long sample section supported an estimated 9 brown trout 3 inches and longer (SE: 0.4). The same sample section supported 2 rainbow trout (SE: 1.0), 2 rainbow-westslope cutthroat trout hybrids, and 2 westslope cutthroat trout. At stream mile 3.0 a 410 foot-long sample section supported 8 westslope cutthroat trout (SE: 0.71), or approximately 20 westlope cutthroat trout greater than 3 inches per 1,000 feet of stream (Figure 59).

During both 1997 and 1999, fish identification was based on external morphometric examination. However, genetic analysis of fish from Papoose Creek differed slightly from our field identification based on external features. In 1994, four fish were collected from Papoose Creek at T11S R02E S06, which approximately encompasses Papoose Creek from stream mile 3.0 upstream to mile 4.0 (J. Brammer, Montana FWP, Dillon, files). Results from genetic analysis of those fish indicated that Papoose Creek supported a genetically pure population of westslope cutthroat trout (Table 5). During 1999 fin clips were taken from 24 westslope cutthroat trout to confirm the purity of this population. A sub-sample of westslope cutthroat trout was fin clipped every half-mile of Papoose Creek from the stream's mouth upstream through stream mile 3.5. DNA analyses through PINE markers of these fin clips revealed that the fish contained genetic material from westslope cutthroat trout, rainbow trout, and Yellowstone cutthroat trout (letter to Brad Shepard from Naohisa Kanda dated November 8, 1999) (Table 5). However, some fish that were pure westslope cutthroat trout (6 of 9) were sampled at mile 2.5, 3.0, and 3.5. The three hybrids above mile 2.5 were hybridized with rainbow trout at a single allele indicating that these fish are slightly hybridized or that they simply contain a rare westlope cutthroat trout genetic variation. All fish below mile 2.5 were either hybrids between rainbow and cutthroat trout (12 of 15) or rainbow trout. Genetic material from Yellowstone cutthroat trout was not detected in fish sampled above stream mile 1.5. The relative purity of hybrids between rainbow trout and cutthroat trout was not reported.

Nowhere Creek

No fish were observed or captured in a 295 foot-long section sampled 0.25 miles above the mouth of Nowhere Creek.

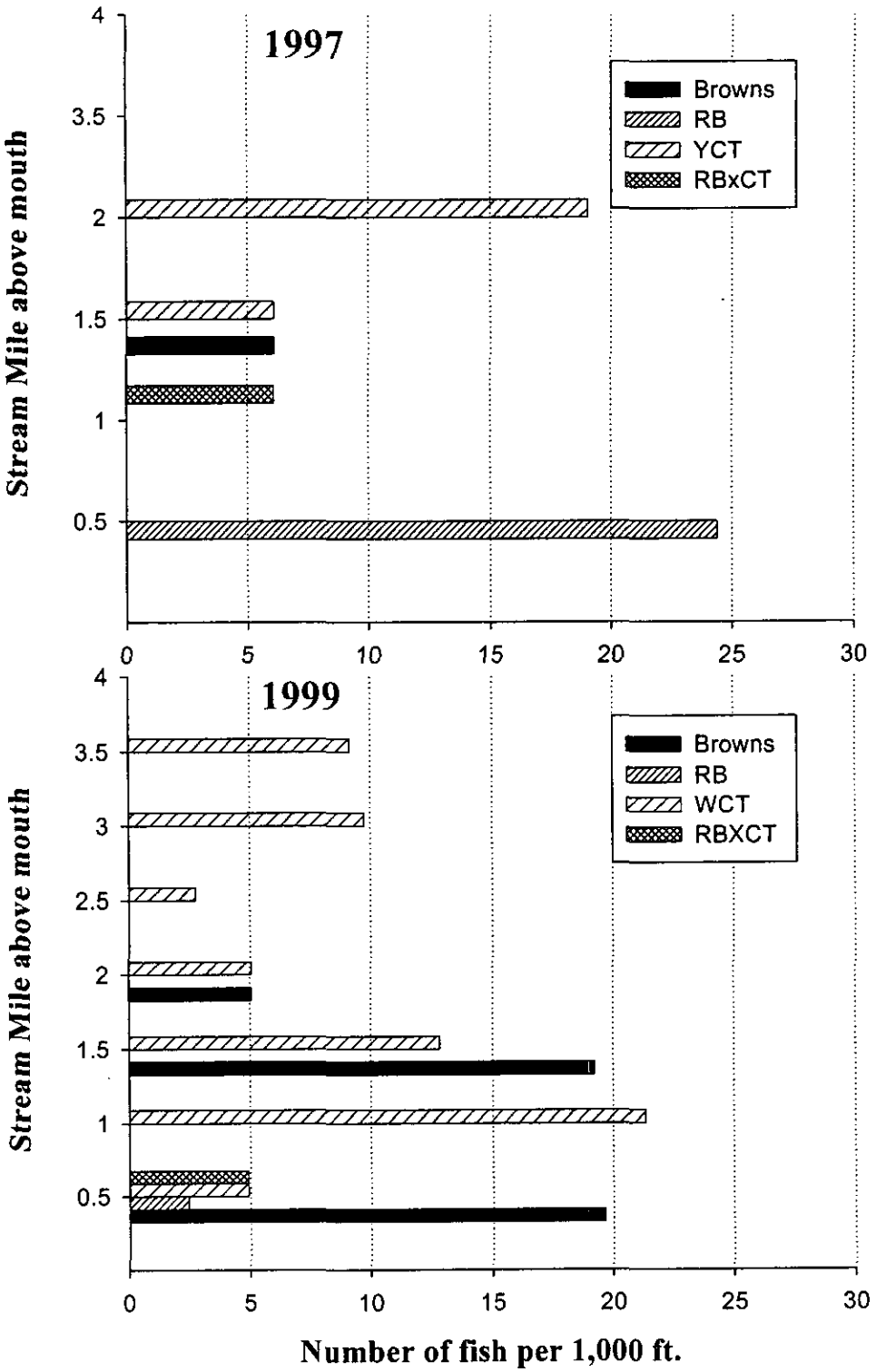

Figure 58. Catch of westslope cutthroat trout (WCT), Yellowstone cutthroat trout (YCT) brown trout, rainbow trout (RB), and hybrids between rainbow trout and cutthroat trout (RBxCT) 3.0 inches and longer per 1,000 feet of stream length in Papoose Creek during 1997 (bottom) and 1998 (top). All sites shown on y-axis were sampled and zero values indicate no fish were captured.

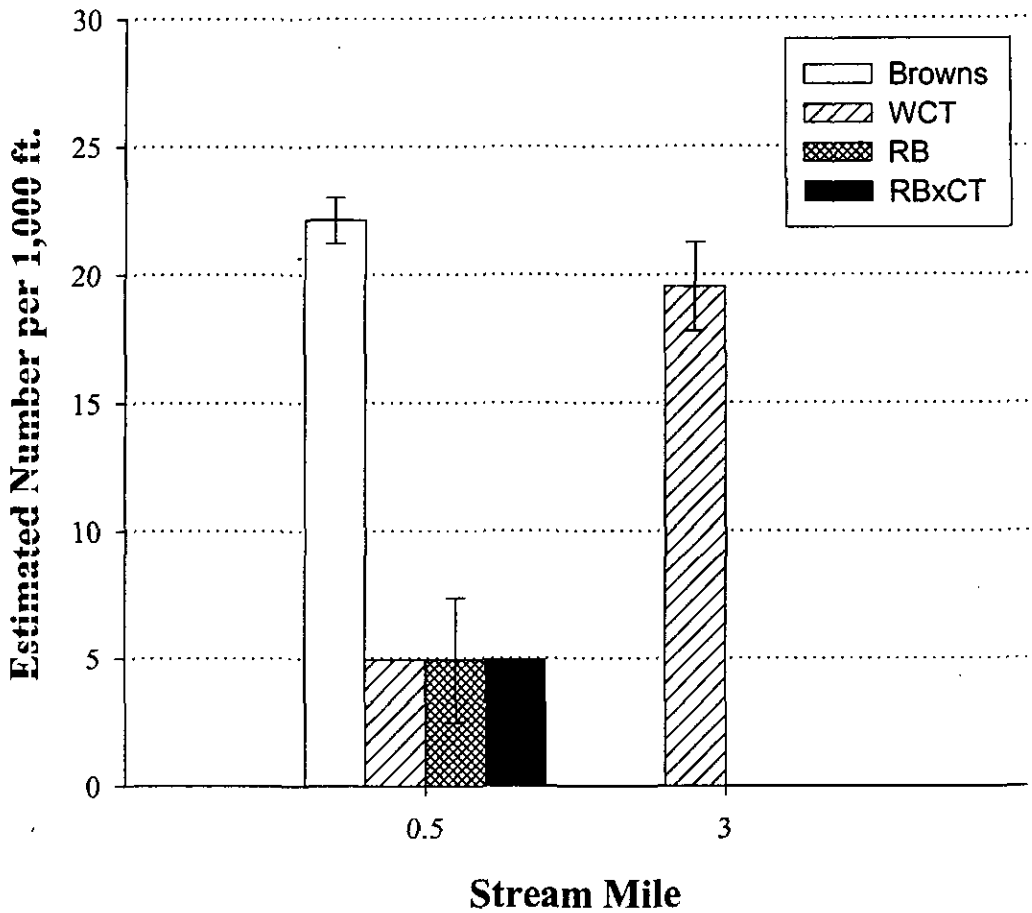

Figure 59. Estimated number of westslope cutthroat trout (WCT), brown trout, rainbow trout (RB), and hybrids between rainbow trout and cutthroat trout (RBxCT) greater than 3 inches long per 1,000 feet of stream length captured in Papoose Creek during 1999. *Vertical lines represent standard errors.*

Fish Length and Weight

Rainbow trout captured in Papoose Creek varied from 13.3 to 15.6 inches in length (Figure 60). Rainbow-westslope cutthroat hybrids varied from 4.7 to 7.6 inches in length. Brown trout varied from 2.5 to 7.7 inches in length, with an average length of 4.4 inches. Westslope cutthroat trout varied from 4.7 to 7.6 inches, with an average length of 6.1 inches.

Comparison to Previous Sampling

Besides the results of genetic analysis of fish captured in 1994 by J. Brammer summarized above there was no record of previous sampling in Papoose Creek from the MRIS database, nor from catalogued reports.

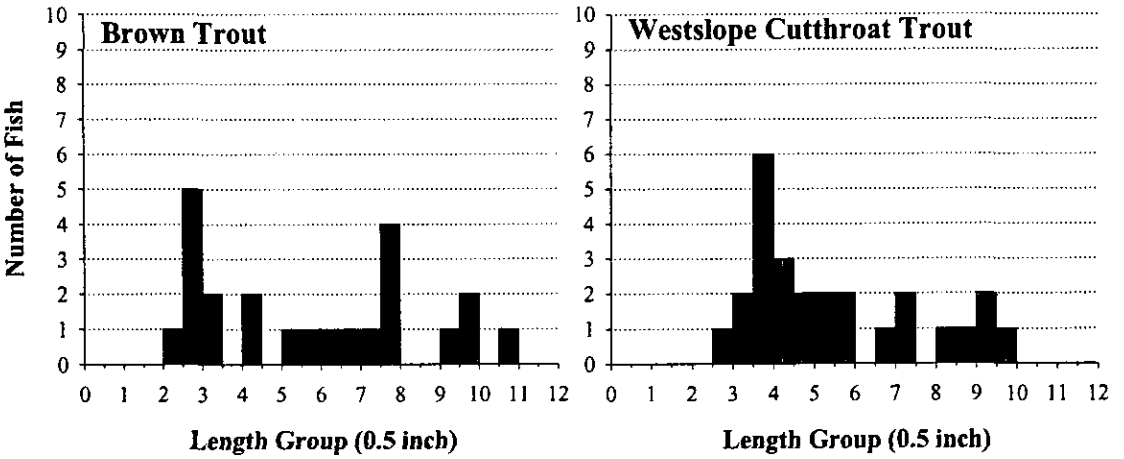

Figure 60. Length frequencies of brown trout (left) and westslope cutthroat trout (right) captured in Papoose Creek during 1999.

Quaking Aspen Creek

Quaking Aspen Creek drains the Gravelley Range and enters the Madison River from the west. Its upper reaches flow through the Beaverhead-Deerlodge National Forest while its lower reaches flow through private lands of the subdivided Sun West Ranch (Figure 1). Quaking Aspen Creek flows through moderately steep forested lands in its upper reaches, flows through a lower gradient meadow area within BLM administered lands in its middle reaches, before flowing through private land in a relatively steep canyon area and finally reaching the Madison River valley bottom. There are no records of fish planting in the Quaking Aspen Creek drainage.

Habitat

An Optic Stowaway® thermograph was placed in Quaking Aspen Creek near its mouth at the Madison River from July 16 to October 11, 1998 (Figure 3). During the summer average daily temperatures generally ranged from 50 to 55°F and maximum daily temperatures never exceeded 65°F (Figure 61).

A reach survey was conducted in Quaking Aspen Creek from just above the ranch buildings at the Sun West Ranch upstream about one mile to stream mile 2.1. This mile of stream was dominated by pool (55%) habitats, followed by riffle (30%) and run habitats (Table 1). Plunge and step pools dominated pool types, while cascades and high gradient riffles dominated riffle types. Two different potential fish barriers were observed during this survey (Figure 4). The lowest barrier was a cascade located at about stream mile 1.3. A waterfall barrier with a 2.5-foot vertical drop was found at stream mile 2.4.

A detailed habitat survey was conducted at mile 1.6, near the lower boundary of the BLM land ownership, in Quaking Aspen Creek. At this site the stream flowed through a moderately low

gradient meadow area. The streambed contained mostly cobble and large and small gravel, each making up about 25% of the stream's bed (Table 2). Small woody debris was abundant, but not much of this debris spanned the channel. Spawning habitat was moderately abundant and deemed adequate at this sample site, but was more limited in other portions of the stream. Instream and bank cover, bank stability, pool quality, and use of riparian habitats were all rated as moderate (Table 3). Riffles dominated the survey section, followed by pools and runs. Average depth in the section was 5.0 inches and the average wetted width was 6.5 feet.

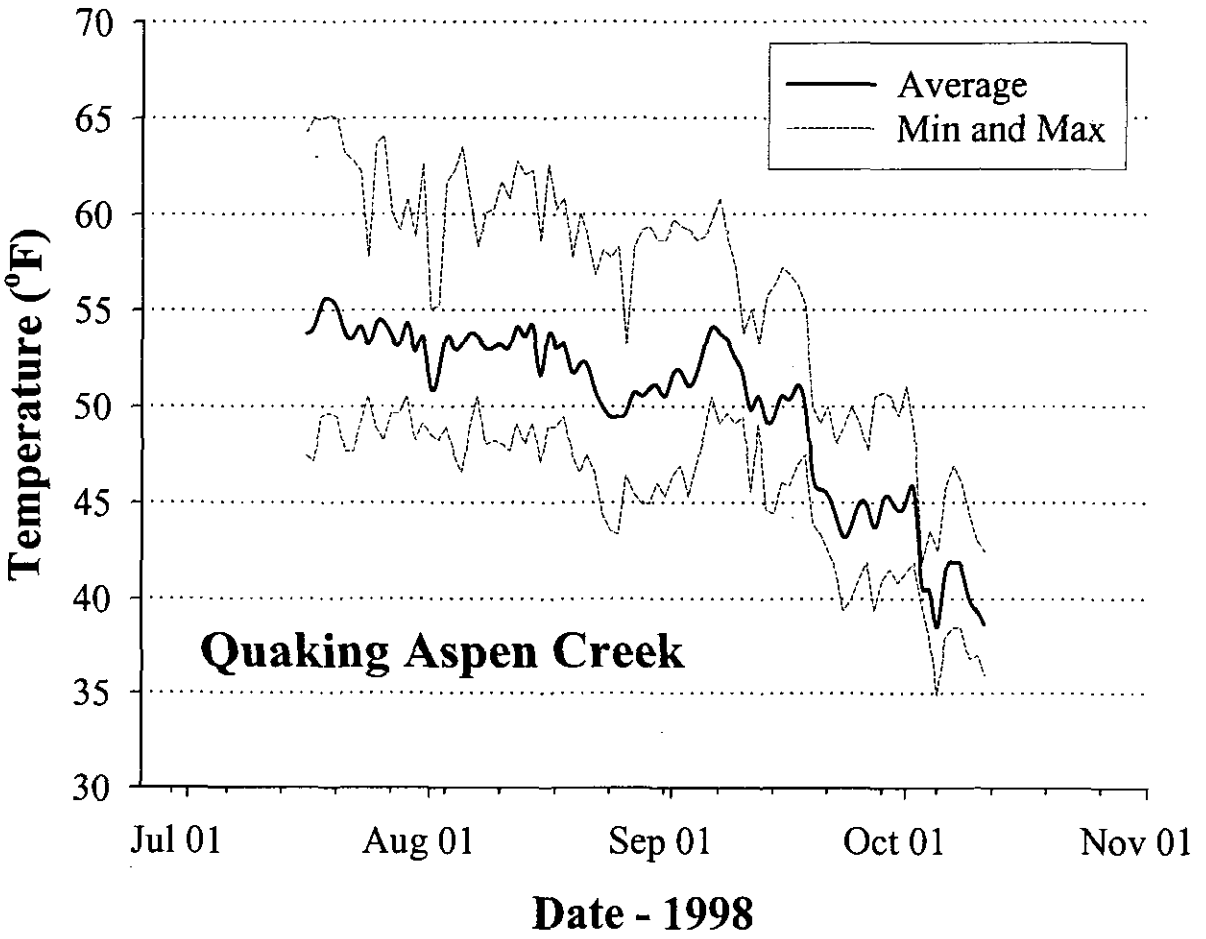

Figure 61. Average, minimum, and maximum daily water temperatures measured in Quaking Aspen Creek near its mouth at the Madison River during the summer of 1998.

Fish Distribution and Abundance

Westslope cutthroat and rainbow trout were found in the lower portion of Quaking Aspen Creek, at stream mile 0.5 immediately above the culvert near the ranch headquarters and at stream mile 1.6 within the BLM land ownership (Figure 62). Above stream mile 1.6 all fish appeared to be westslope cutthroat trout, but a DNA analysis done on tissue samples from three fish indicated

that rainbow trout were introgressed (up to 23% near mile 1.0) with the westslope cutthroat trout. All three fish captured at stream mile 2.0 were hybrids. At stream mile 2.1, just above a four wheel drive road crossing, four westslope cutthroat trout were captured in a 280 foot-long sample section. No fish were captured above the 2.5 foot high falls seen at stream mile 2.4 though two sites were sampled, one just above the falls and another at stream mile 2.6.

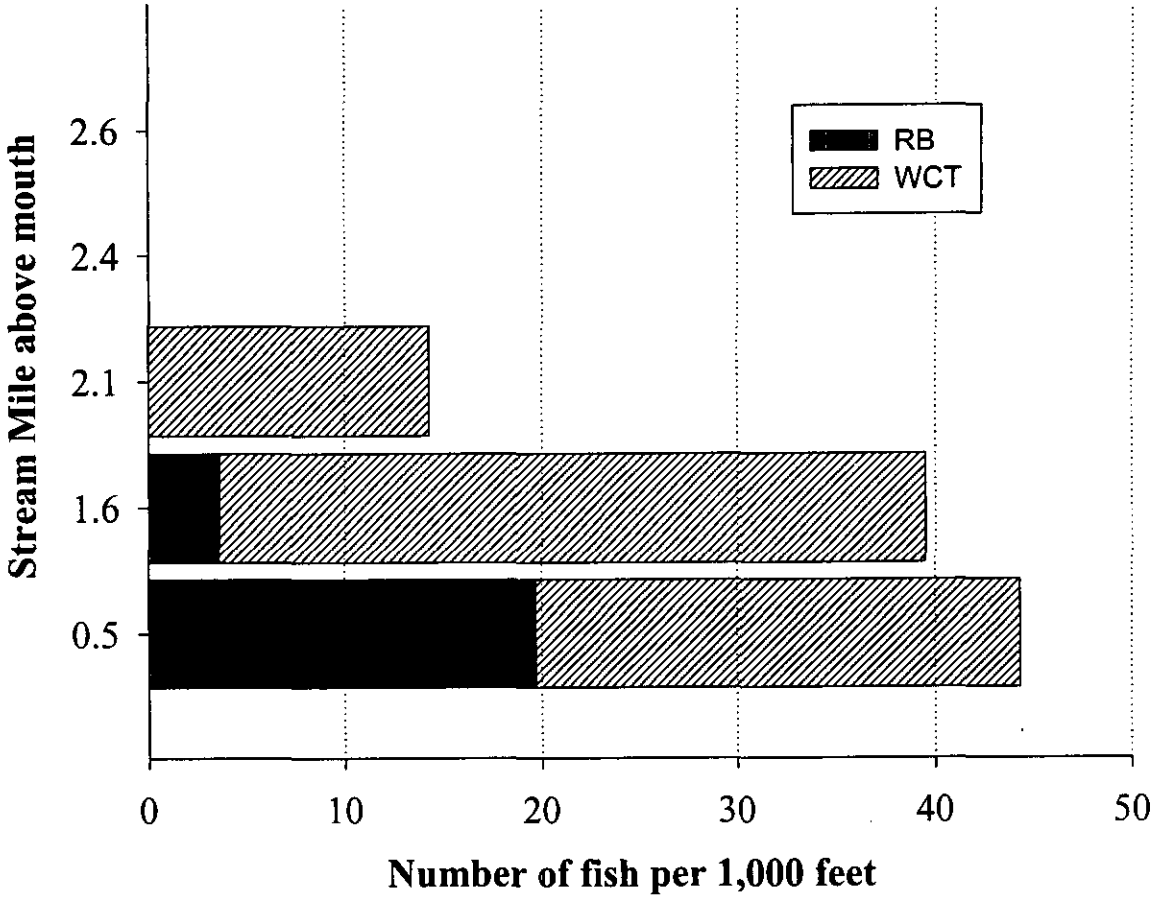

Figure 62. Catch of rainbow (RB) and westslope cutthroat (WCT) trout 3.0 inches and longer per 1,000 feet of stream length in five sections of Quaking Aspen Creek (by stream mile) during summer 1998. All sites (miles) along the y-axis were sampled and zero values indicate no fish were captured at those sites.

A depletion population estimate was made in Quaking Aspen Creek at mile 1.6. A 279 foot-long section at mile 1.6 supported an estimated 16 (SE: 0.9) westslope and rainbow trout 3 inches and longer which translates to about 60 fish per 1,000 feet of stream length (Appendix E).

Fish Length and Weight

Westslope cutthroat trout in Quaking Aspen Creek averaged about 4.0 inches and the longest fish captured was a 6.5-inch fish (Appendix F). It appeared that only two size classes were represented in 1998 (Figure 63). Age 1 fish were probably from 2.5 to 4.5 inches long and age 2 and older fish were longer than 4.5 inches. No age 0 fish were captured.

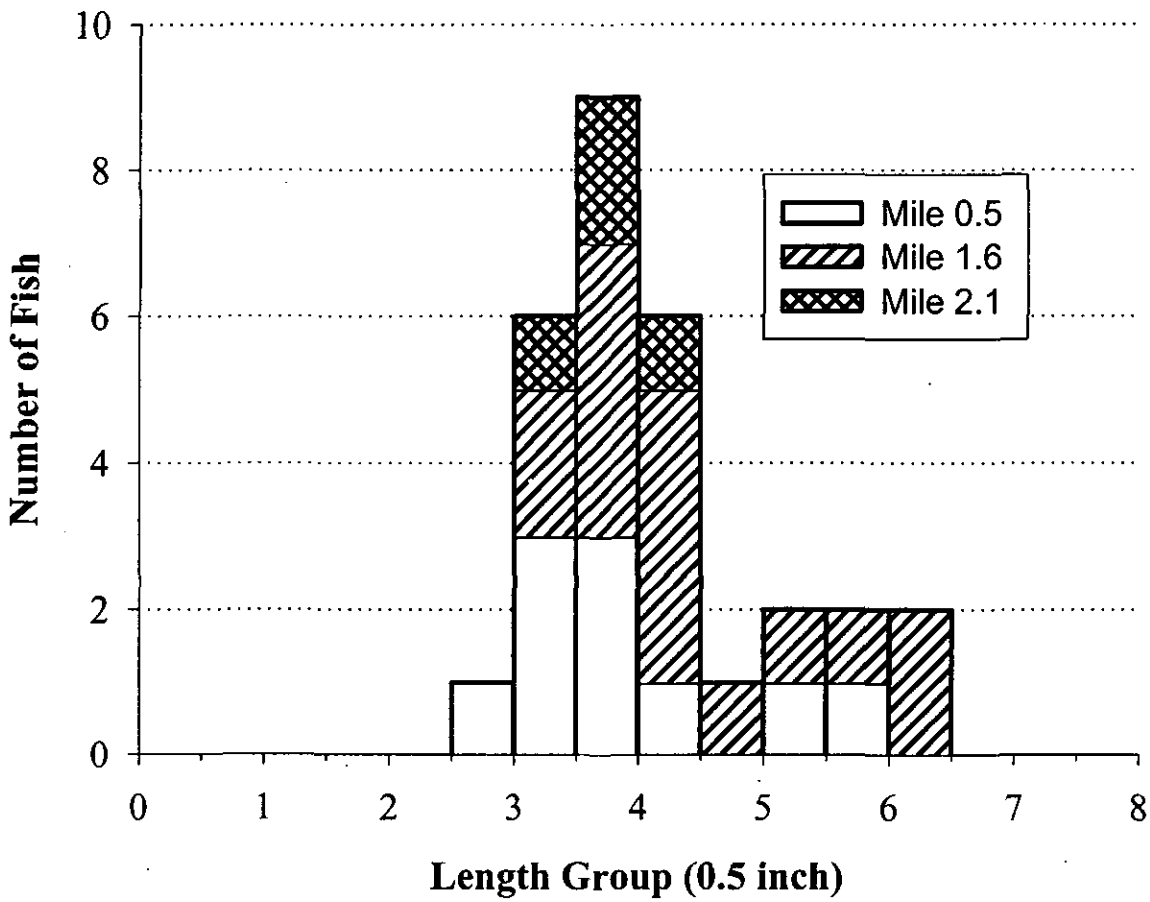

Figure 63. Length frequency histograms by stream mile for westslope cutthroat trout captured in Quaking Aspen Creek during the summer of 1998.

Comparison to Previous Sampling

There are no records for Quaking Aspen Creek in the MRIS or from catalogued reports.

Ruby Creek

Ruby Creek enters the Madison River from the west. It drains the Gravelly Range. Its upper reaches flow through the Beaverhead-Deerlodge National Forest while its lower reaches lie within Montana Fish, Wildlife and Parks' Wall Creek Wildlife Management Area (Figure 1). Ruby Creek has several major tributaries, including the South Fork (enters Ruby Creek at stream mile 5.1), Dry Fork (enters at mile 5.3), Grindstone Gulch (enters at mile 7.1), and Beartrap Canyon (enters at mile 8.3). The South Fork of Ruby Creek has one major tributary, Skunk Creek, that enters the South Fork at stream mile 0.8. Main Ruby Creek is approximately 16 miles in length. The South Fork is approximately 4.3 miles long. Main Ruby Creek and the South Fork flow through moderately steep forested lands in their upper reaches before flowing out through a transitional zone with mixed coniferous and deciduous trees and moderate gradients. Both streams then flow through a lower gradient meadow area. Main Ruby Creek flows over an approximately six-foot waterfall at about mile 0.7 (Figure 4). This waterfall is created by a shelf of conglomerate rock and is presently a barrier to upstream fish movement.

The Montana FWP fish-planting database indicated that 4,400 undesignated cutthroat trout fry were planted into Ruby Creek in 1931 (Appendix G). No other records of fish planting in streams of the Ruby Creek drainage were found.

Habitat

Since no westslope cutthroat trout were captured in Ruby Creek, no detailed habitat surveys were conducted.

Fish Distribution and Abundance

Brown trout dominated the lower 0.7 miles up to the canyon and falls area at about stream mile 0.7, while only rainbow trout and mottled sculpins were found above the canyon area up to mile 6.5 (Figure 64). No fish were captured in any of five sample sections from stream mile 8.0 up to stream mile 13.2 near the headwaters of Ruby Creek. The sample section at mile 6.5 was extremely short (about 33 feet) and contained a high quality plunge pool that made up about half the sample section, thus the relative abundance of rainbow trout in this section was positively biased. No sampling was done in any tributaries; however, our observations of Dry Fork, Grindstone Gulch, and Beartrap Canyon indicated that fish probably do not inhabit these tributaries due to extremely low or intermittent stream flows. Since no westslope cutthroat trout were found in Ruby Creek, no population estimates were made.

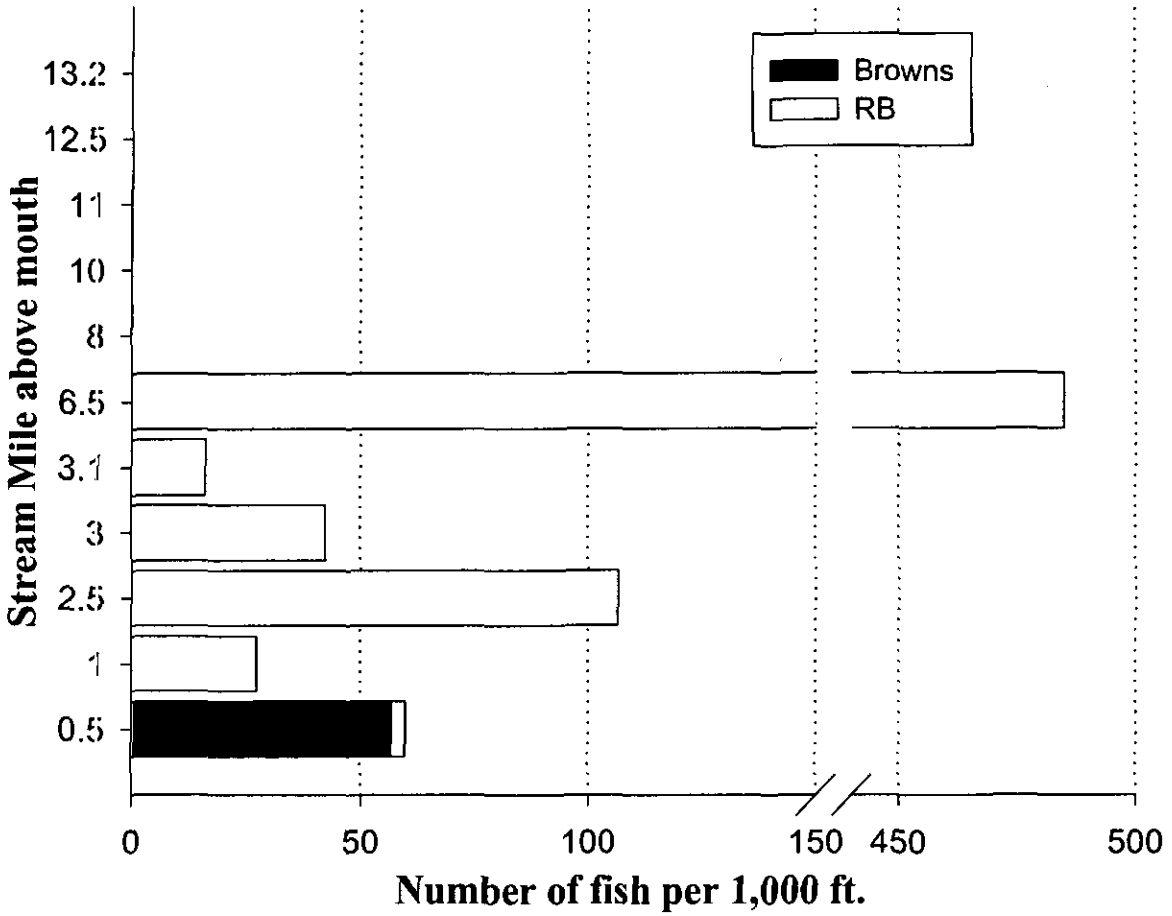

Figure 64. Catch of brown and rainbow trout (RB) 3.0 inches and longer per 1,000 feet of stream length by stream mile in Ruby Creek during 1997. All stream miles along the y-axis were sampled, so zero values indicate no fish were captured at these sites. The sample section at stream mile 6.5 was a short section that was made up primarily of a single high-quality pool, so the relative abundance at this site was positively biased (note break in axis and bar).

Fish Length and Weight

Brown trout captured at mile 0.5 in lower Ruby Creek averaged 5.3 inches (range 1.8 – 9.3; n=22) and the only rainbow trout captured at mile 0.5 was 9.0 inches long (Appendix F and Figure 65). Rainbow trout averaged from about 5 to 8 inches in all other sections where they were captured (Appendix F). Rainbow under 4.5 inches were only captured at mile 6.5, and the largest rainbow captured (13.3 inches) was also captured at this site (Figure 65). Many rainbow trout longer than 9.0 inches were captured during sampling.

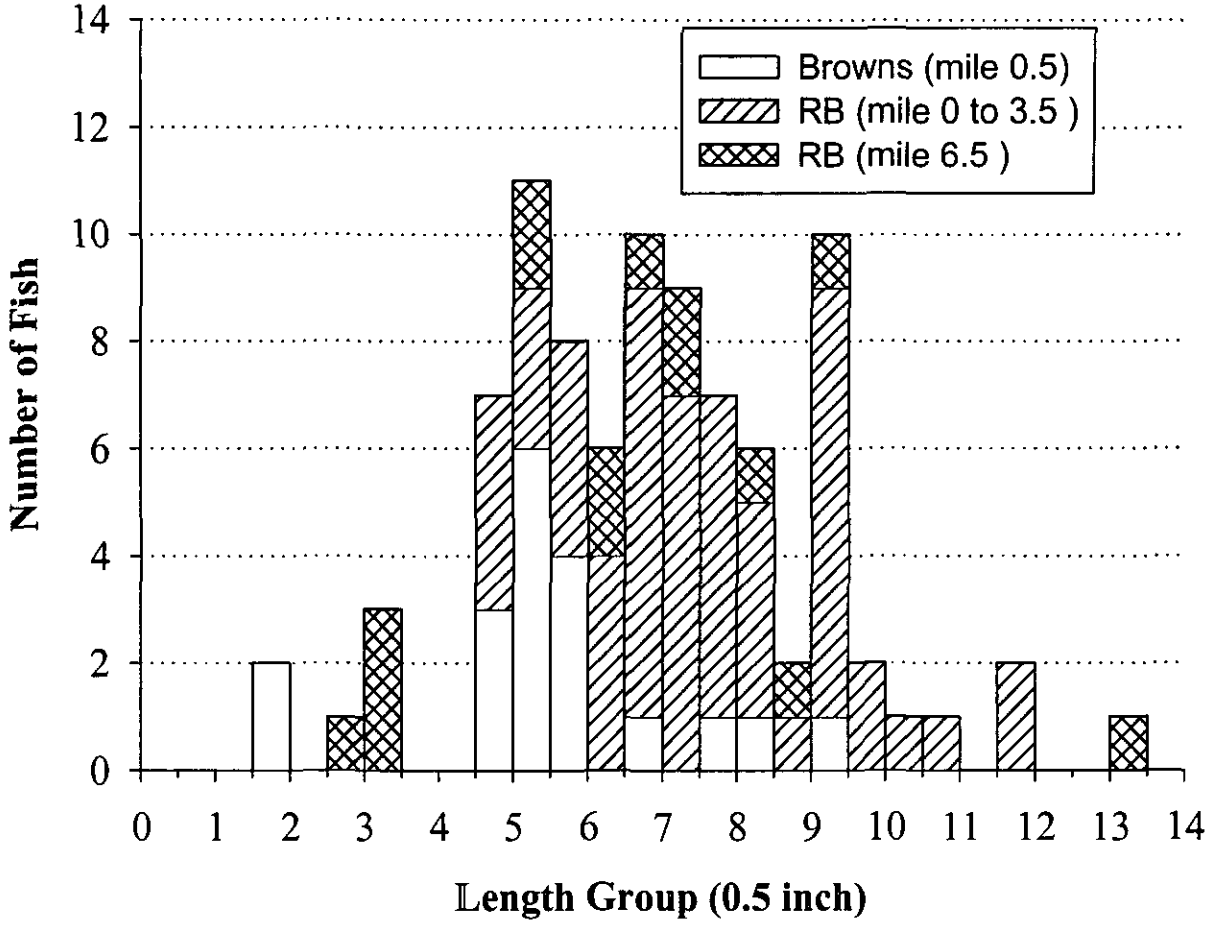

Figure 65. Length frequency histograms for brown and rainbow trout (RB) captured in Ruby Creek during 1997 by stream mile.

Comparison to Previous Sampling

Previous habitat sampling in Ruby Creek divided the stream into seven reaches (J. Brammer, Montana FWP, Dillon, MT, files). The lower portion of the creek on private land was not surveyed. Reach 2 began at the confluence of the South Fork and extended upstream 1.5 miles to just below an old homestead. This reach was in good condition and suitable for fish. Rainbow trout were captured via angling, but no westlope cutthroat trout were seen. Reach 3 began below the old homestead and extended up to confluence with Beartrap Canyon Creek. Fish were present in about 0.1 mile of this reach where flow was suitable, but flows diminished to nearly dry in the upper portion of this reach. Reach 4 extended upstream from Beartrap Canyon Creek to up through a narrow granite canyon. The flows in this reach were described as "just a trickle" and no fish were found. The rest of the stream above this reach was deemed marginal for fish due to low flows and extremely unstable streambed due to slides in the drainage upstream.

Shell Creek

Shell Creek is a 4.5-mile long stream draining the Madison Range. The stream flows through a narrow V-shaped canyon in its upper reaches. After leaving the Madison Range 1.5 miles above its mouth, Shell Creek encounters the Cedar Creek alluvial fan and subsequently loses surface flow. A single pass electrofishing effort was made at stream mile 1.75. No fish were observed or captured in the 246 foot-long sample section. Based on this sampling, Shell Creek appears fishless.

Soap Creek

Soap Creek enters the West Fork of the Madison River from the north about two miles above its junction with the main Madison River (Figure 1). Soap Creek originates in the Gravelly Mountains and flows in a southerly direction 5.5 miles before entering the West Fork. The upper portion of the stream was dry during the summer of 1993 (see below). The stream flows through a relatively steep coniferous forest for most of its length. A few small meadow areas are interspersed within the forest and the stream channel gradient is lower through these meadows. A private pond exists on the stream channel about 0.3 miles above its mouth. Two cascading waterfalls exist about 0.7 miles above this pond (mile 1.0). These waterfalls prevent non-native rainbow trout and rainbow-cutthroat trout hybrids from ascending into the upper portion of the drainage. There are no records of fish planting in the Soap Creek drainage.

Habitat

Soap Creek had about 15-25% of its channel length in pool habitats, but riffles predominated in all four habitat survey sections (Table 4). Pool quality was good to excellent with average pool depths from 13 to 17 cm (Tables 3 and 4). Most pools were plunge pools created by logs and rocks in the lower three sections (miles 1.2, 1.6, and 2.4) and lateral scour pools in the upper meadow section (mile 3.4). Instream and bank cover was rated as good to excellent and little riparian use was observed (Table 3). Instream and bank cover consisted primarily of woody debris. The streambed had a small proportion of fine material (sand and silt), especially in the lower two sections (miles 1.2 and 1.6; Table 2). Cobble and boulders dominated the streambed. Woody debris and spawning habitat was moderately abundant throughout the creek (Table 2).

Fish Distribution and Abundance

Only westslope cutthroat trout were captured during all sampling efforts above two log and rock falls located approximately 1.0 mile above Soap Creek's mouth at the West Fork of the Madison River (Figure 66 and Appendix D). There is a private pond on the stream channel between the West Fork and these falls. Rainbow trout, hybrids between rainbow and cutthroat trout, and one cutthroat trout were taken in a sample section below the lower of the two falls during October 1993 sampling (Figure 66). No fish were captured at mile 3.54, which was located in a high gradient portion of the stream channel above an old beaver pond meadow area, during July sampling. The channel was dry at mile 5.5.

During summer sampling relative densities of cutthroat trout were similar in all sample sections in 1993, variable in 1994, and declined in an upstream direction in 1995 (Figure 66 and Appendix D). Relative abundances were generally lower in 1994 and 1995 than in 1993. For a few sections the sacrifice of some fish in 1993 for genetic analyses and otoliths for age confirmation likely influenced this result.

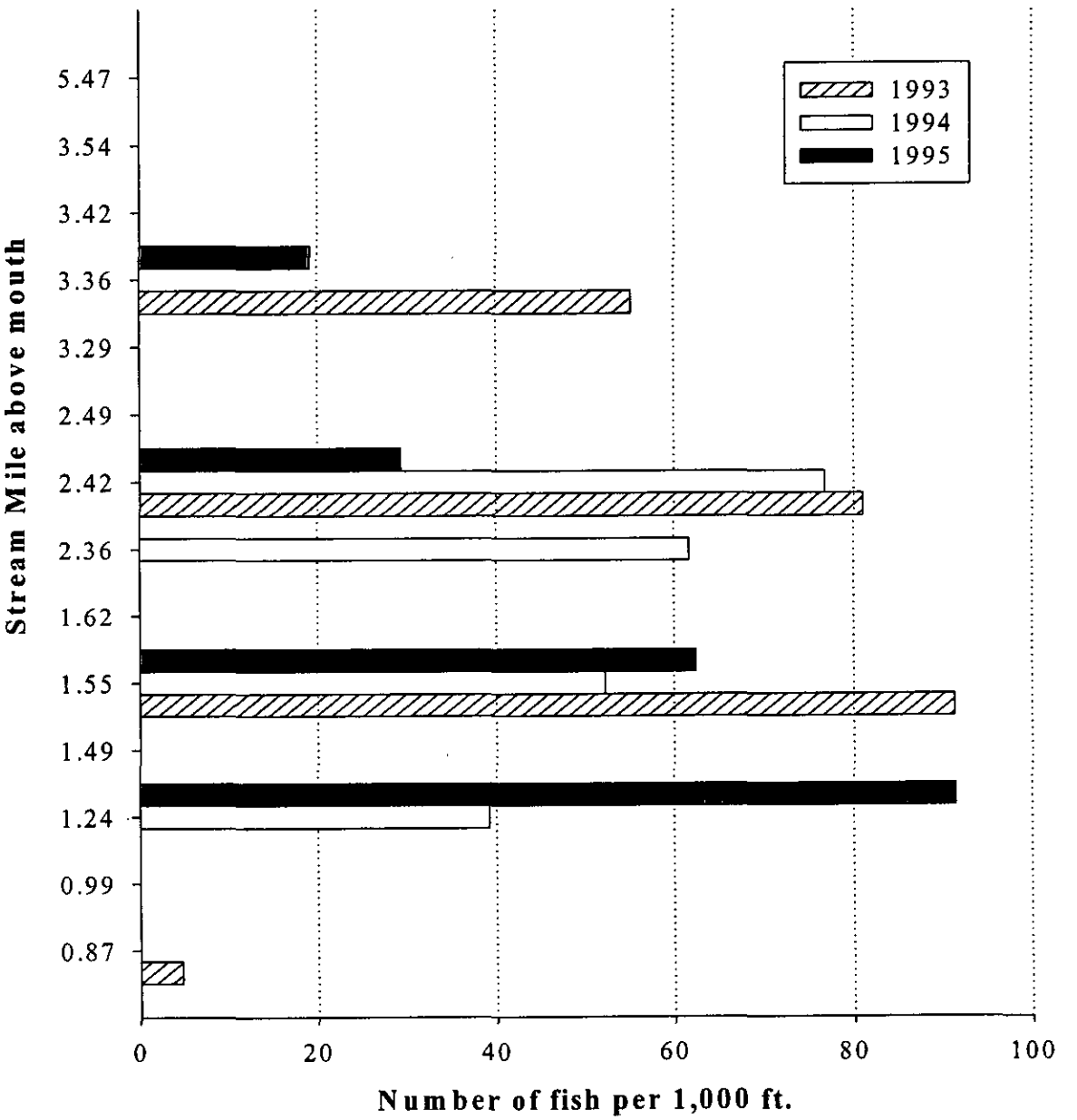

Figure 66. Catch of westslope cutthroat trout 3.0 inches and longer per 1,000 feet of stream length in Soap Creek during the summers of 1993, 1994, and 1995. All sample sites shown on y-axis were sampled at least once and zero values indicate no fish were captured at these sites.

During May and June 1994 sampling to document spawning movements sampling efficiencies were poor due to high runoff flows, so the relative catches should be viewed with caution (Appendix D). Few fish were captured in the meadow section (mile 3.36), but all fish captured had been previously marked in 1993. Mature females and ripe males were captured in both sections. No fish were captured at mile 3.54, above the meadow area, during the summer 1993 or spring 1994. Since no fish were captured at this upper location we assume the upper portion of the creek is probably not used by fish. In June 1994, mature and ripe females, as well as ripe males, were captured at mile 2.36 and 2.42 (Appendix D). More fish were captured at mile 2.36, below the Freezeout Road culvert, than immediately above the culvert (Appendix D). This suggests that some spawning cutthroat trout may be moving upstream to spawn. However, during the spawning season tagged adult cutthroat were found within sample sections in which they were tagged the previous summer (seen at mile 3.36) suggesting that some adults may not be moving to spawn. These data suggest spawning movements vary for individual fish and may be related to availability of spawning habitats. October 1993 sampling found higher relative abundances of westslope cutthroat trout in many of the sections than was seen during the summer of 1993. However, these higher abundances might have been related to higher sampling efficiencies due to lower stream flows (Appendix D).

Populations estimates were conducted at miles 1.24, 1.55, 2.42, and 3.36 (Figure 67 and Appendix E). Estimated numbers of westslope cutthroat trout 3 inches and longer increased from 1994 to 1995 at mile 1.24. Estimated numbers declined slightly from 1993 to 1995 at mile 1.55 and declined dramatically at miles 2.42 and 3.36. It may be that some fish moved downstream from 1993, a relatively high summer flow year, to 1994 and 1995, relatively average and low flow years, respectively.

Fish Length and Weight

Length frequency histograms and average length summaries showed that Soap Creek supported cutthroat across a relatively broad range of sizes in most areas of the creek (Appendix F and Figure 68). Nodes in the length frequency histograms for cutthroat suggest that age 1 fish were 1.5 to 2.5 inches during the summer of 1993 and 2.0 to 3.5 inches during the summers of 1994 and 1995. Age 2 fish were 3.5 to 6.0 inches in 1994 and 1995, but were only 3.5 to 5.0 inches in 1993 (Figure 68). No fry were captured during summer sampling in either 1993 or 1995, but a few were captured in 1994 (Figure 68). Several fry were captured in the lower creek in October 1993. Three small cutthroat (< 2.0 inches) were captured during May and June 1994 sampling, suggesting that some age 0 cutthroat overwintered at lengths less than 2.0 inches (Appendix F).

Westslope cutthroat trout in Soap Creek tagged at lengths from 4.5 to 6.0 inches grew about 1.7 inches per year based on nine tag-recaptured fish. Those that were tagged at 6.0 inches and longer grew about 0.9 inches per year based on 13 tag-recaptured fish.

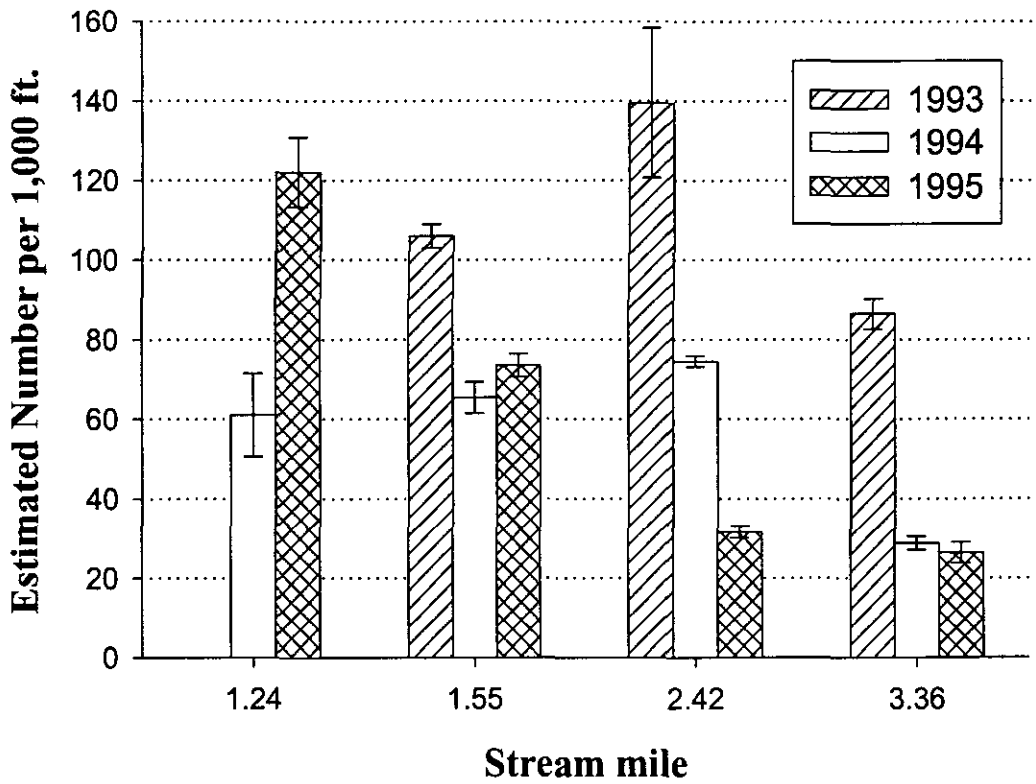

Figure 67. Estimated number of westslope cutthroat trout 3 inches and longer in Soap Creek (verticle lines represent standard errors) at four locations (measured as stream mile above the mouth) in 1993 through 1995.

Fish Movement

Tag returns indicated that recaptured westslope cutthroat trout in Soap Creek moved very little between sampling periods. Of 23 recapture events, 18 (78%) of the fish were recaptured within the same section where they were last captured. Only five fish moved, and none of those fish moved further than 350 feet. Three of the fish had moved downstream and two had moved upstream. Although tagged fish showed little movement, we captured many new fish (fish that had not been previously tagged during earlier sampling) in sample sections between years, suggesting that some movement was likely occurring.

Comparison to Previous Sampling

There are no records of previous sampling for the Soap Creek from the MRIS, nor from catalogued reports.

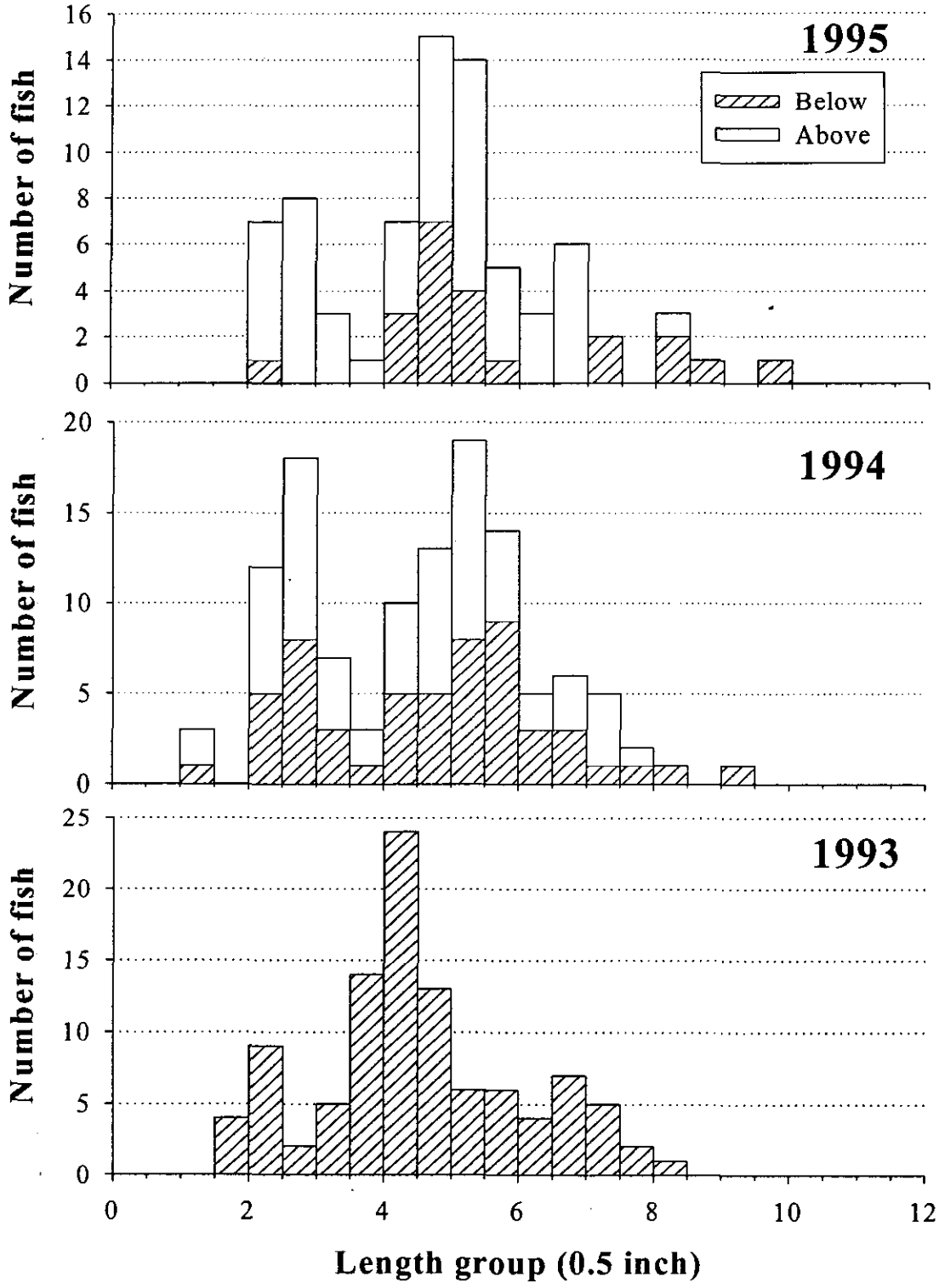

Figure 68. Length frequency histograms for westslope cutthroat trout captured above and below a fish barrier at stream mile 1.0 in Soap Creek during the summers of 1993, 1994 and 1995.

South Fork of Indian Creek

The South Fork of Indian Creek is a 7 mile-long tributary to Indian Creek originating in the Lee Metcalf Wilderness Area (Figure 1). The stream flows predominately through conifer forest interspersed with open, grassy meadows. Tributaries to the South Fork of Indian Creek are too small to support resident salmonid populations. A high gradient, cascading reach beginning at stream mile 4.25, culminates in a 100 foot-high waterfall at stream mile 5.0, creating a major barrier to upstream fish movement (Figure 4). The Montana FWP fish-planting database contains no records for the South Fork of Indian Creek.

Habitat

A 0.75-mile reach survey was conducted in the South Fork of Indian Creek beginning at the creek's mouth. This was a relatively high gradient reach with riffle habitat types dominating the stream channel (54%) (Table 1). Pools, primarily plunge scour pools, were next most abundant (44%). A second reach survey was made from the first unnamed tributary upstream approximately two miles to the mouth of the third unnamed tributary. Riffle habitat types dominated the second reach (53%) with low and high gradient riffle seen in nearly equal numbers. Pools, primarily lateral scour pools, composed approximately 38% of the habitat types in the second reach (Table 1).

A detailed habitat survey was conducted in the South Fork of Indian Creek at stream miles 1.5 and 4.5. At stream mile 1.5 the streambed was dominated by small and large gravel substrate (Table 2). Woody debris and spawning habitat were extremely abundant. Pool habitat quality, bank cover, and bank stability were all high (Table 3). Instream cover was moderate. Riparian use by both cattle and wildlife was high. At stream mile 4.5 the streambed was dominated by cobble substrate. Woody debris and spawning habitat were moderately abundant. Instream cover and pool habitat quality were fair, as were bank cover and bank stability. Riparian use was low. Average wetted width ranged from 14.4 to 18.9 feet, and average water depth ranged from 6.1 to 8.6 inches.

Fish Distribution and Abundance

Rainbow trout and westslope cutthroat trout were present in the South Fork of Indian Creek. No other fish species were observed or captured. Fin clips were taken from a total of 25 fish captured at stream miles 1.0, 1.5, 2.0, 2.5, 3.0 and 3.5 during 1998 sampling. Captured westslope cutthroat did not appear introgressed (hybridized) with rainbow trout based on external morphometric examination. However, DNA analyses through PINE markers of fin clips revealed that westslope cutthroat trout composed only about 79% of the markers (Table 5). Genetic material from both rainbow trout (15%) and Yellowstone cutthroat trout (6%) were also found. Although fish from the South Fork Indian Creek were all classified as hybrids between westslope cutthroat trout, rainbow trout, and Yellowstone cutthroat trout, fish from stream mile 2.5 to 3.5 contained over 90% westslope cutthroat trout alleles, while fish from lower in the drainage contained much lower westslope cutthroat trout allele frequencies (letter to Brad Shepard from Naohisa Kanda dated November 8, 1999).

A total of four rainbow trout were captured in the South Fork: 3 at stream mile 1.0 and one at stream mile 1.5 (Figure 69). Westslope cutthroat trout were captured at stream miles 1.0, 1.5,

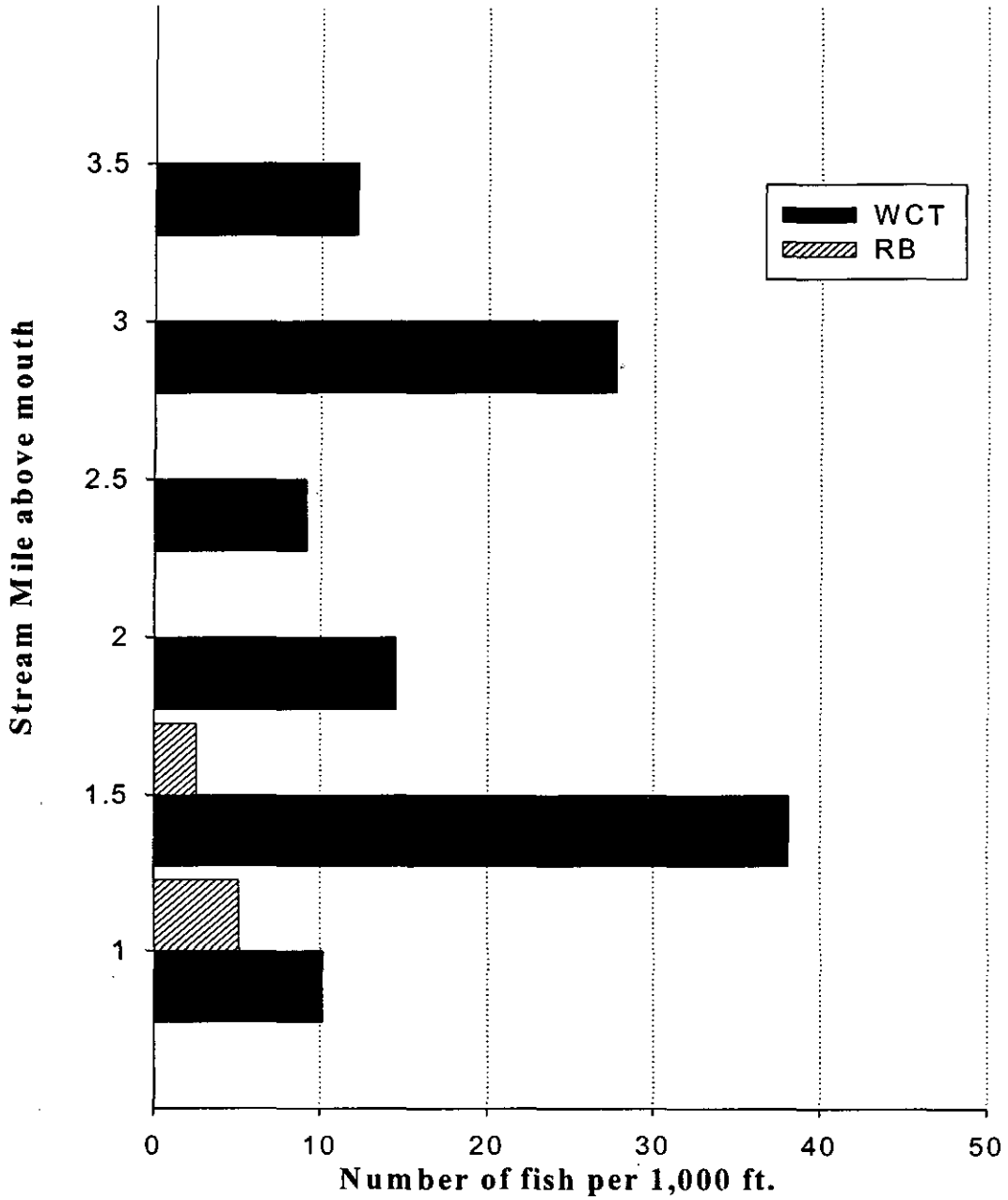

Figure 69. Catch of westslope cutthroat trout (WCT) and rainbow trout (RB) 3 inches and longer per 1,000 feet of stream length in the South Fork of Indian Creek during the summer of 1998.

2.0, 2.5, 3.0 and 3.5. Relative abundances of westslope cutthroat trout ranged from 9 to 38 trout 3 inches and longer per 1000 feet of stream length (Figure 69). No fish were captured in sample sections at stream miles 4.5, or 5.0, which were located above barriers to upstream fish movement. We were unable to sample at stream mile 0.5 and 4.0 because of extremely high channel gradients.

A three-pass depletion estimate was made 1.5 miles above the mouth of the South Fork. The 394 foot-long sample section supported an estimated 21 (SE: 0.70) westslope cutthroat trout, with 9 (SE: 0.46) of these fish between 3 and 6 inches long, and 12 (SE: 0.53) of these fish between 6 and 12 inches long (Appendix E). This estimate translates to 53.3 westslope cutthroat trout 3 inches and longer per 1000 feet of stream channel.

Fish Length and Weight

Rainbow trout ranged from 2.7 to 8.1 inches in length with an average length of 5.8 inches (Figure 70). Westslope cutthroat trout ranged from 3.0 to 11.9 inches in length with an average length of 7.1 inches. Average lengths of westslope cutthroat trout ranged from 6.4 to 9.0 inches by sample section and generally increased in upstream sample sections.

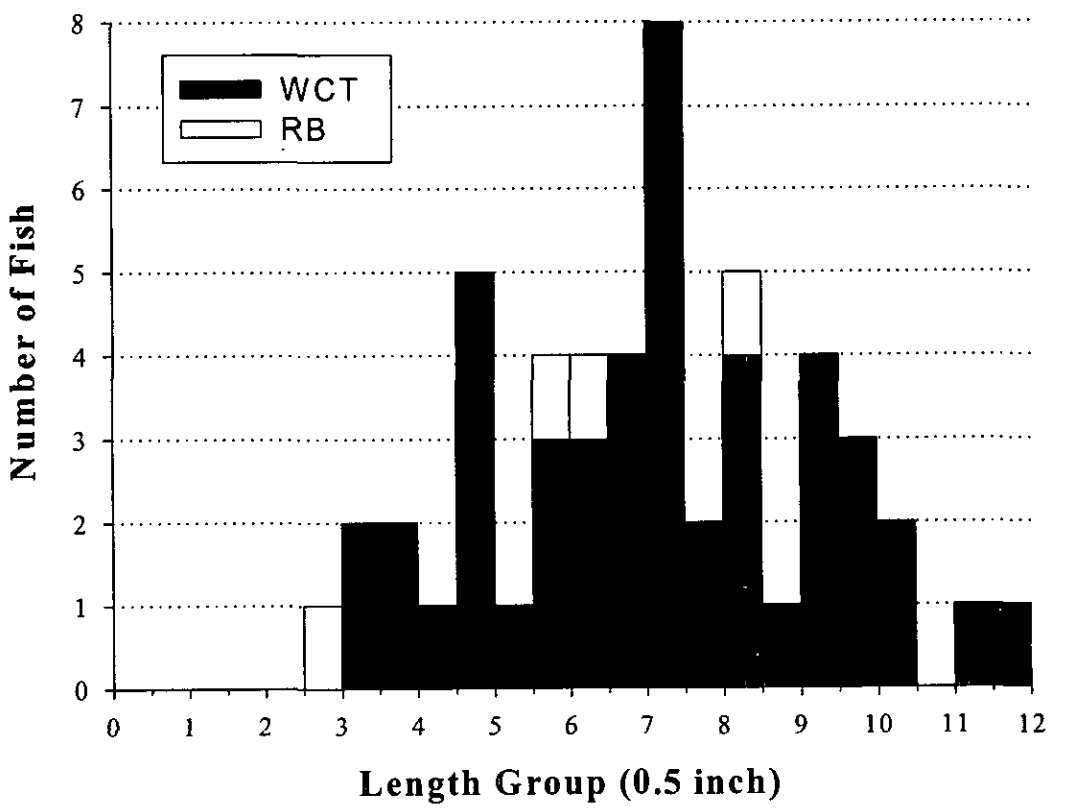

Figure 70. Length frequencies of westslope cutthroat trout (WCT) and rainbow trout (RB) captured in the South Fork of Indian Creek during 1998 sampling.

Comparison to Previous Sampling

There are no records of previous sampling for the South Fork of Indian Creek from the MRIS, nor from catalogued reports.

Squaw Creek

Squaw Creek is an 8 mile-long stream originating in the Lee Metcalf Wilderness Area and draining the Madison Range (Figure 1). Echo Lake and several smaller, unnamed lakes are the headwaters for Squaw Creek. The stream flows through conifer forest interspersed with open, grassy meadows throughout its entire length. During the summer of 1999 the stream channel was dry from stream mile 5.25 to 5.75 but quickly regained average flow above and below this intermittent reach. Squaw Creek has three tributaries: the North, Middle, and South forks of Squaw Creek. The North Fork enters Squaw Creek at stream mile 5.2, the Middle Fork at mile 2.25, and the South Fork just below stream mile 2.0. The North Fork is a 2.5 mile-long stream. Cooney Lake and several other small boggy lakes are the headwaters for the North Fork. A 60 foot-high waterfall is located approximately 0.5 miles above the stream's mouth. Below this waterfall the stream channel is over-widened and unstable due to excessive bedload deposition and offers little in the way of fish habitat. Dutchman Lake and several smaller lakes are the headwaters for the Middle Fork of Squaw Creek. In its upper reaches the Middle Fork flows through open, steep, talus slopes interspersed with small stands of conifers. In its lower reaches it flows through coniferous forest interspersed with open, grassy meadows. At stream mile 4.2 a 25 foot-high cascade-falls complex prevents upstream fish movement. From the headwater lakes downstream to this barrier falls salmonid habitat is very limited because of high channel gradients (between 20% and 40%) (J. Brammer, Montana FWP, Dillon, files). The South Fork of Squaw Creek is a small stream flowing entirely through privately owned lands. A series of springs and seeps form the South Fork approximately 0.75 miles upstream from its mouth. Several small spring fed streams enter the South Fork throughout its length.

The Montana FWP fish planting database indicates that 13,064 brown trout were planted on 7/22/47 near the mouth of Squaw Creek (Appendix G). Echo Lake, in the headwaters of Squaw Creek, has also received regular fish plantings. Echo Lake was last planted with Yellowstone cutthroat trout during the summer of 1993 (P. Clancey, Montana FWP,Bozeman, files). Dutchman Lake, in the headwaters of the Middle Fork of Squaw Creek, has been on a similar fish planting schedule, last receiving Yellowstone cutthroat trout during the summer of 1995 (P. Clancey, Montana FWP, Bozeman, files)

Habitat

Stream temperature was measured from July 7 through September 26, 1999 in Squaw Creek at the stream's mouth, and at stream miles 2.0, 4.0, 5.0 and 7.0 using Onset Optic Stowaway® thermographs (Figure 3). Except for temperatures at stream mile 7.0, mean, maximum, and daily fluctuations in temperature decreased in an upstream direction, with the lowest values occurring at stream mile 5.0 (Figure 71). Temperatures at the furthest upstream thermograph (stream mile 7.0) were comparable to those near the stream's mouth. Mean summer temperatures ranged from

48.5 to 43.4°F. Stream temperatures fluctuated from <1.0 to 11.7°F daily. Maximum summer temperatures never exceeded 58.0°F.

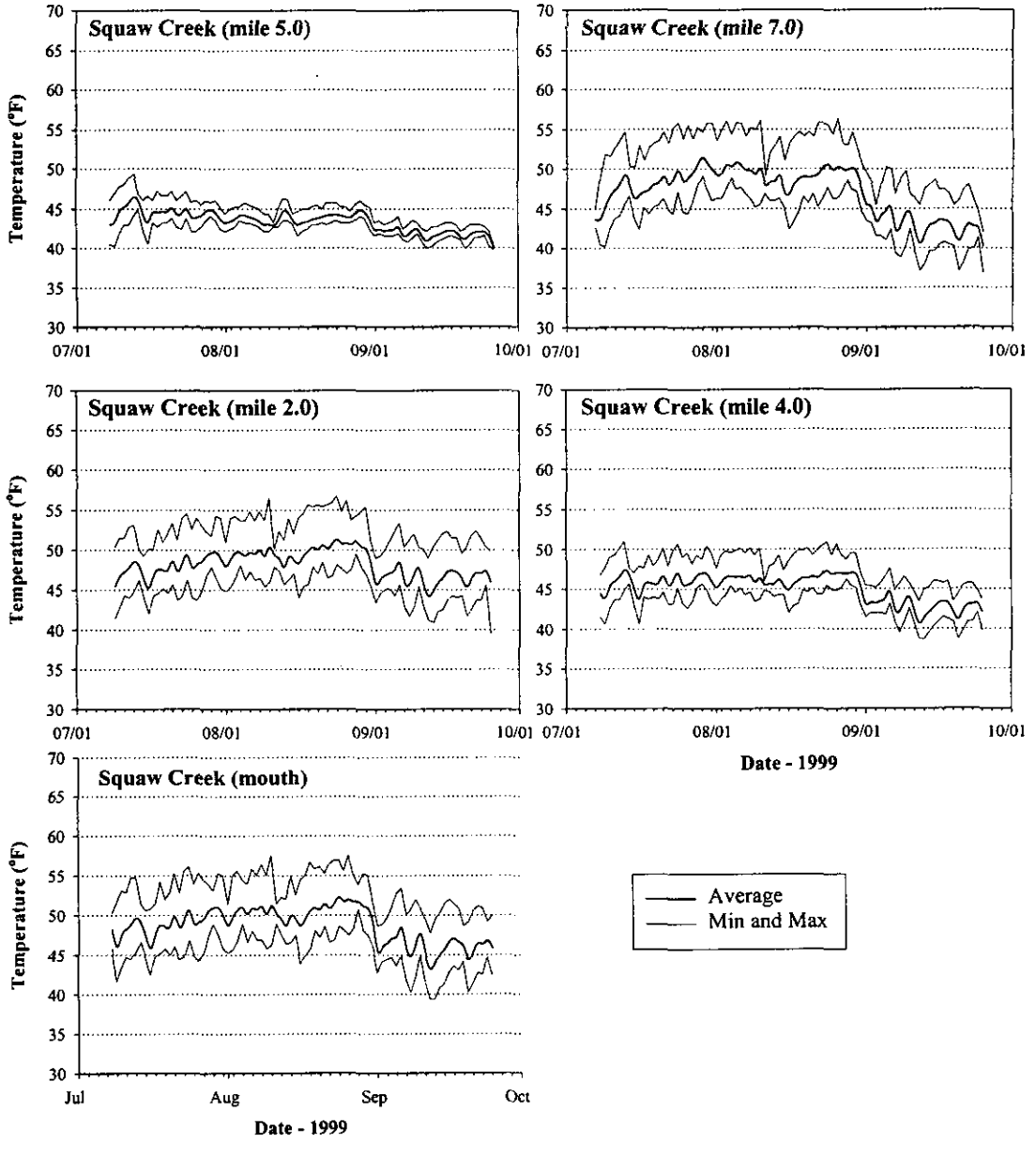

Figure 71. Average, minimum, and maximum stream temperatures at five locations in Squaw Creek during 1999.

Thermographs were also placed at the mouth of the North, Middle and South forks of Squaw Creek on July 7 and left to record stream temperatures until September 26, 1999 (Figure 3). Mean summer stream temperature for the North Fork was 44.6°F (Figure 72). Stream

temperatures fluctuated 1.1 to 6.4°F degrees daily, and the maximum stream temperature recorded was 49.5°F. In the Middle Fork, the average summer stream temperature was 45.2°F. Stream temperatures fluctuated 1.5 to 7.8°F daily, and maximum summer temperature remained relatively cool at 51.2°F. In the South Fork, the average summer stream temperature was 53.5°F. Stream temperatures fluctuated 2.5 to 14.3°F daily, and the maximum stream temperature recorded was 64.1°F.

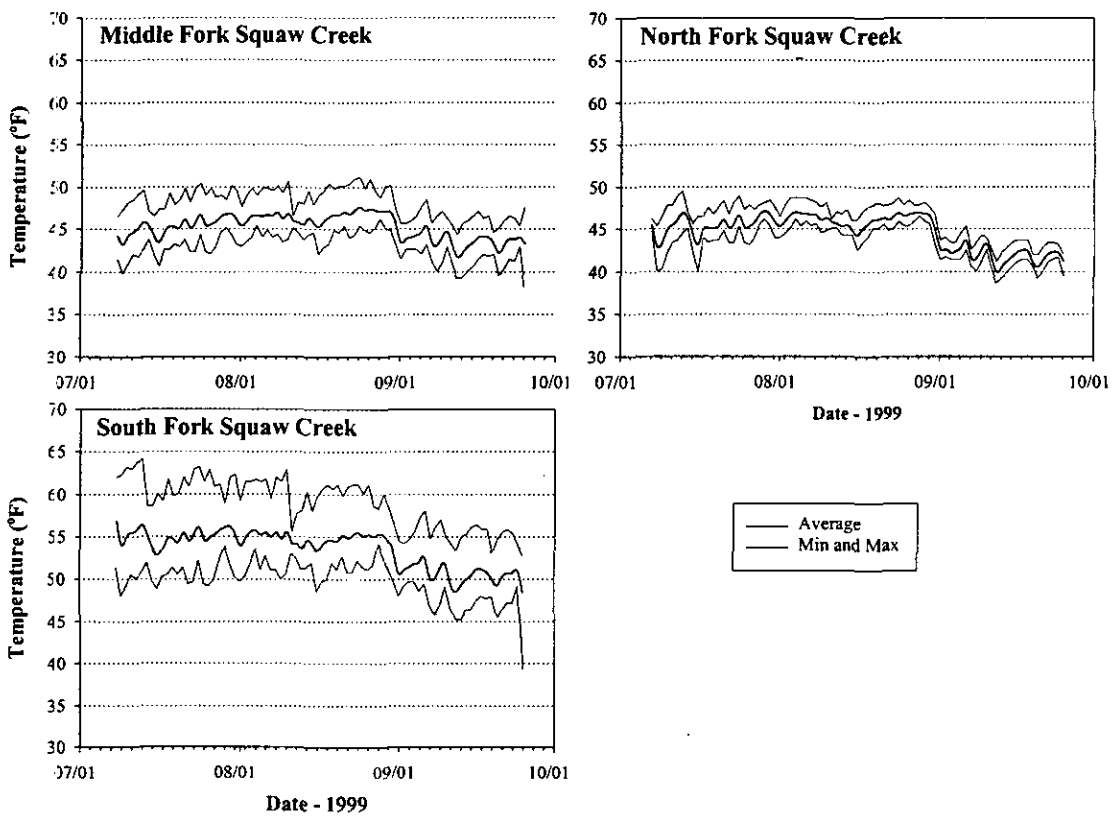

Figure 72. Average, minimum, and maximum stream temperatures in the North, Middle, and South forks of Squaw Creek near the streams' mouth during 1999.

Squaw Creek

A detailed habitat survey was conducted at stream mile 2.0, 4.0, 6.0, and 8.0 in Squaw Creek. At stream mile 2.0 the streambed was dominated by large and small gravel (Table 2). Woody debris was moderately abundant. Spawning habitat was excellent. Instream cover, bank cover, bank stability, and pool habitat all received moderate ratings (Table 3). Riparian use from both livestock and wildlife was apparent. At stream mile 4.0 the streambed was dominated by cobble substrate (Table 2). Woody debris and spawning habitat was relatively abundant. Instream cover, bank cover, bank stability, and pool habitat received moderate ratings (Table 3). Riparian use was relatively light. Large gravel and cobble comprised the majority of the streambed at

stream mile 6.0 (Table 2). Woody debris was moderately abundant. Spawning habitat was limited because of a lack of small substrate. Pool habitat was relatively abundant. Instream cover, bank cover, and bank stability received poor ratings (Table 3). No riparian use was apparent. At stream mile 8.0 small and large gravels predominated the streambed (Table 2). Woody debris was rare, probably a result of this sample section being located directly below Echo Lake. Spawning habitat was excellent, and probably adequate to sustain the trout population in Echo Lake. Streambank stability was excellent. Instream cover, bank cover, and pool habitat were moderate to poor (Table 3). Riparian habitat received limited wildlife use.

Middle Fork of Squaw Creek

A detailed habitat survey was conducted in the Middle Fork of Squaw Creek at stream mile 2.5 and 3.0. At stream mile 2.5 the stream channel was poorly defined and provided minimal fish habitat. The streambed was dominated by large gravel and cobble substrates (Table 2). Woody debris and spawning habitat were rare. Pool habitat was nonexistent. Instream cover, bank cover, and bank stability were all very poor (Table 3). Riparian use from livestock was moderate. At stream mile 3.0 the streambed was dominated by cobble (Table 2). Woody debris and spawning habitat were moderately abundant. Pool habitat was fair to good. Instream cover, bank cover, and bank stability were moderate (Table 3). Use of riparian habitats by wildlife was minimal.

North Fork and South Fork of Squaw Creek

Detailed habitat surveys were not made in the North Fork or South Fork of Squaw Creek.

Fish Distribution and Abundance

Squaw Creek

Brown trout, rainbow trout, and rainbow-cutthroat trout hybrids were captured in Squaw Creek. Brown trout were captured in Squaw Creek from the lowest sample section at stream mile 0.5 upstream through stream mile 3.0. Rainbow-cutthroat trout hybrids were captured in sample sections located 0.5, 1.0, 2.0, 3.0, 3.5, 4.0, 5.0, 7.0, and 8.0 miles above the stream's mouth (Figure 73). A total of 5 rainbow trout were captured in Squaw Creek: two at stream mile 0.5 and three at stream mile 1.0. No fish were captured at stream mile 6.0. The relative abundance of brown trout was generally high in sample sections were they were captured, with the exception of stream mile 3.0 where only 1 brown trout was captured. Except for stream mile 3.0, relative abundance of brown trout increased in an upstream direction (Figure 73). The relative abundances of rainbow-cutthroat trout hybrids was generally low in sample sections where they were captured except at stream miles 3.0 and 8.0 where abundances were 56.83 and 53.8 hybrid trout 3 inches and longer per 1000 feet of stream, respectively. Sculpin were also present in lower sample sections of Squaw Creek.

Depletion population estimates were made at 2.0, 4.0, and 8.0 miles above the mouth of Squaw Creek. At stream mile 2.0, a 410 foot-long sample section supported an estimated 32 brown trout

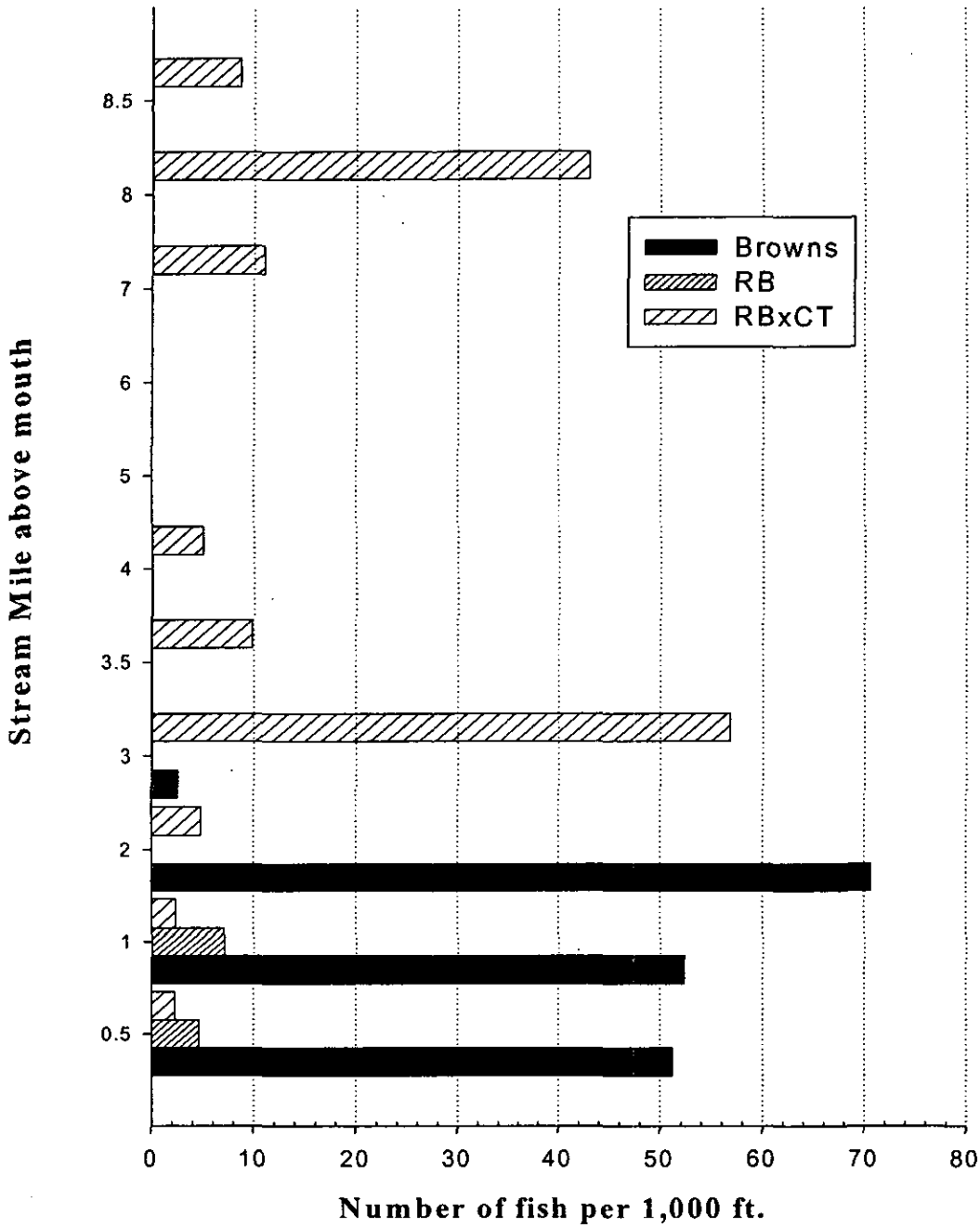

Figure 73. Catch of brown trout, rainbow trout (RB), and hybrids between rainbow trout and cutthroat trout by stream mile in Squaw Creek during 1999. All sites on the y-axis were sampled and zero values indicate no fish were captured.

3 inches and longer (SE: 0.6), or approximately 78 brown trout per 1,000 feet of stream length (Figure 74 and Appendix E). The sample section also supported an estimated 3 rainbow-cutthroat trout hybrids (SE: 0.75), all of which were between 6 and 12 inches in length. At stream mile 4.0, a 397 foot-long sample section supported an estimated 3 rainbow-cutthroat trout hybrids, all of which were between 6 and 12 inches in length. At stream mile 8.0, a 279 foot-long sample section supported an estimated 15 rainbow-cutthroat trout hybrids 3 inches and longer (SE: 0.9) or approximately 54 trout per 1,000 feet of stream length(Figure 74).

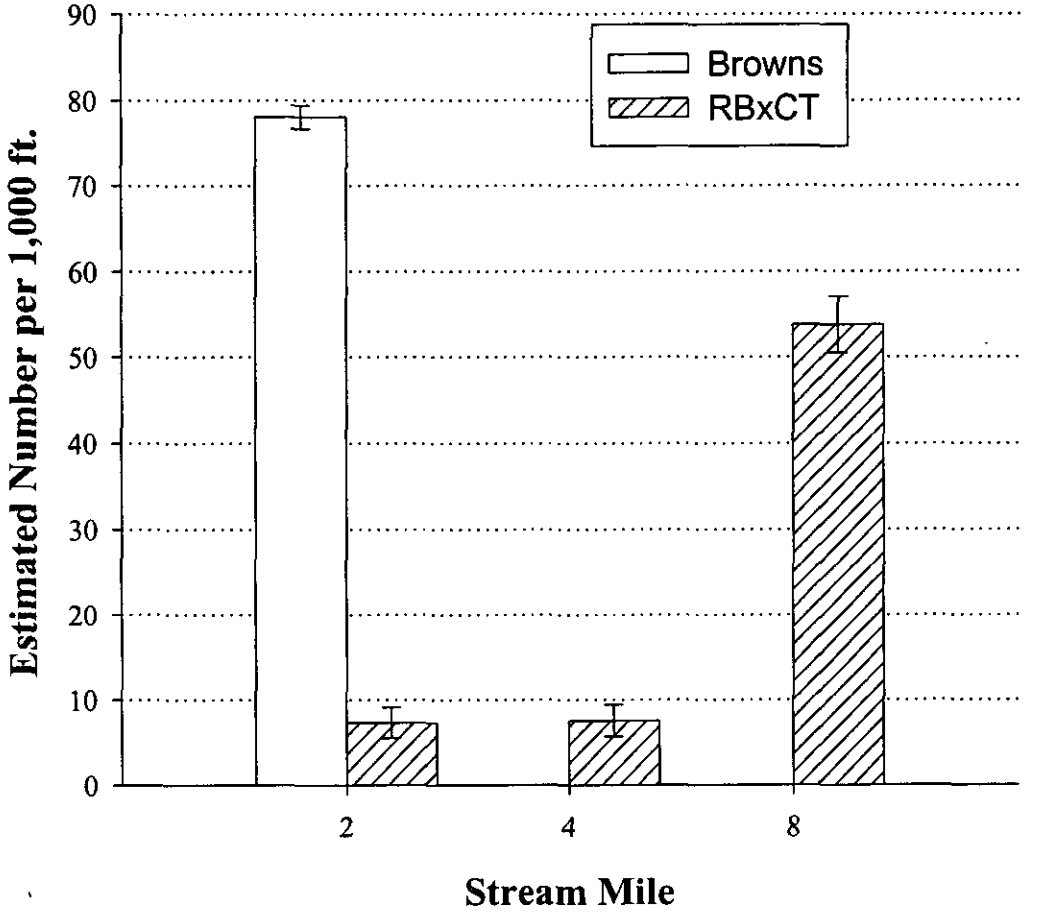

Figure 74. Estimated number of brown trout and hybrids between rainbow trout and cutthroat trout (RBxCT) 3 inches and larger in Squaw Creek during 1999. Verticle lines represent standard errors.

North Fork of Squaw Creek

Hybrids between rainbow trout and cutthroat trout were captured in the North Fork of Squaw Creek just above the stream's mouth. Two rainbow-cutthroat trout hybrids were captured in the 272 foot-long sample section, both of which were between 6 and 12 inches in length. No fish were captured in a 246 foot-long sample section at stream mile 0.5 (Figure 75).

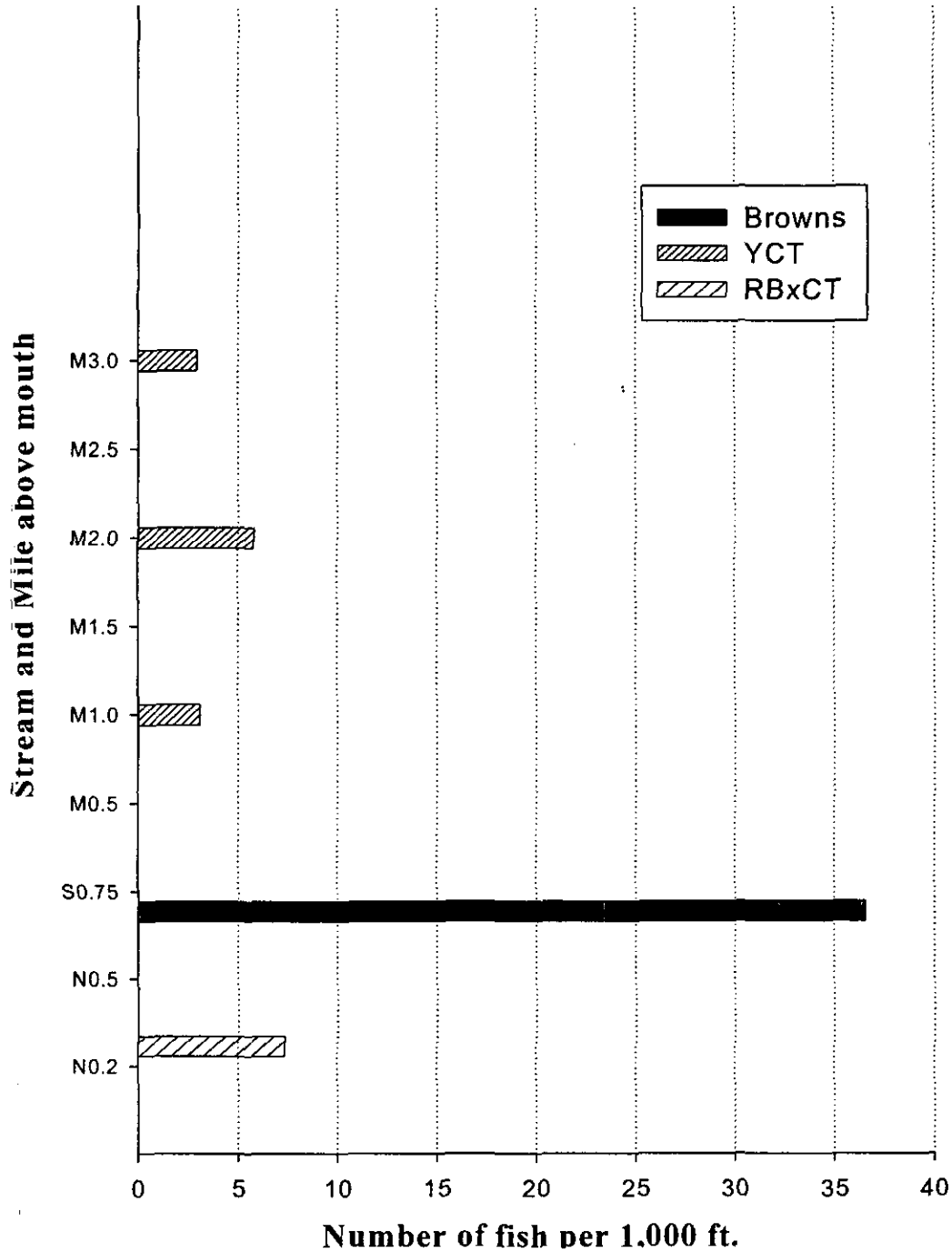

Figure 75. Catch of brown trout, Yellowstone cutthroat trout (YCT), and hybrids between rainbow trout and cutthroat trout (RBxCT) in the North (N and stream mile), Middle (M and stream mile), and South (S and stream mile) forks of Squaw Creek during 1999. All sites (miles) along the y-axis were sampled and zero values indicate no fish were captured at those sites.

Middle Fork of Squaw Creek

A total of four Yellowstone cutthroat trout were captured in the Middle Fork of Squaw Creek in sample sections at stream mile 1.0, 2.0, and 3.0 (Figure 75). No other fish species were captured. No population estimates were made since the relative abundance of Yellowstone cutthroat trout was extremely low in sample sections where they were captured. One fish was captured at stream miles 1.0, and 3.0, and two fish were captured at stream mile 2.0. Yellowstone cutthroat trout in the Middle Fork of Squaw Creek probably were flushed from Dutchman Lake during high flows. No fish were captured in sample sections at stream mile 0.5, 1.5, 2.5, 3.5, and 4.0.

South Fork of Squaw Creek

Brown trout were captured in the South Fork of Squaw Creek at stream mile 0.75 (Figure 75). Ten brown trout were captured in the 246 foot-long sample section, of which one was less than 3 inches in length, and 9 were between 3 and 6 inches. Sculpin were also abundant in the South Fork of Squaw Creek.

Fish Length and Weight

Brown trout captured in Squaw Creek ranged from 1.8 inches to 11.8 inches in length (Figure 77). Average lengths of brown trout increased in an upstream direction, ranging from 6.0 inches at stream mile 0.5 to 10.6 inches at stream mile 3.0. Rainbow-cutthroat trout hybrids ranged from 2.0 inches to 10.2 inches in length (Figure 77). Average lengths of hybrid trout generally ranged between 7 and 9 inches. Rainbow trout captured in Squaw Creek ranged from 5.2 to 8.9 inches in length with an average length of 7.2 inches. Rainbow-cutthroat trout hybrids captured in the North Fork of Squaw Creek ranged from 9.4 to 9.8 inches in length, with an average length of 9.6 inches (Figure 76). In the Middle Fork of Squaw Creek, captured Yellowstone cutthroat trout ranged from 8.7 to 13 inches in length, with an average length of 11.5 inches (Figure 76). Brown trout captured in the South Fork of Squaw Creek ranged from 2.0 to 5.7 inches in length, with an average length of 4.4 inches (Figure 76).

Comparison to Previous Sampling

Our results differ slightly from the results of two previous inventories conducted in the Squaw Creek drainage. The first, conducted in July 1980, found an estimated 110 brown trout and 70 rainbow trout greater than 3 inches per 1000 feet of stream length in lower Squaw Creek (Montana Resource Information System). Brown trout ranged from 5.5 to 14.9 inches long, and rainbow trout ranged from 3.3 to 11.2 inches long. Our estimates for brown trout are slightly lower but comparable to previous sampling. However, our estimates for hybrids between rainbow trout and cutthroat trout in lower sample sections are substantially lower than the estimated number of rainbow trout in 1980. The second inventory, conducted in August 1996 found an estimated 18 rainbow-cutthroat trout hybrids greater than 3 inches per 1,000 feet of stream length at stream mile 4.5 (J. Brammer, MDFWP, files). Additionally, 5 rainbow-cutthroat trout hybrids were captured at stream mile 6.25. Rainbow-cutthroat trout hybrids ranged from 6.8 to 12.6 inches long. Our estimates for hybrids between rainbow trout and cutthroat trout at

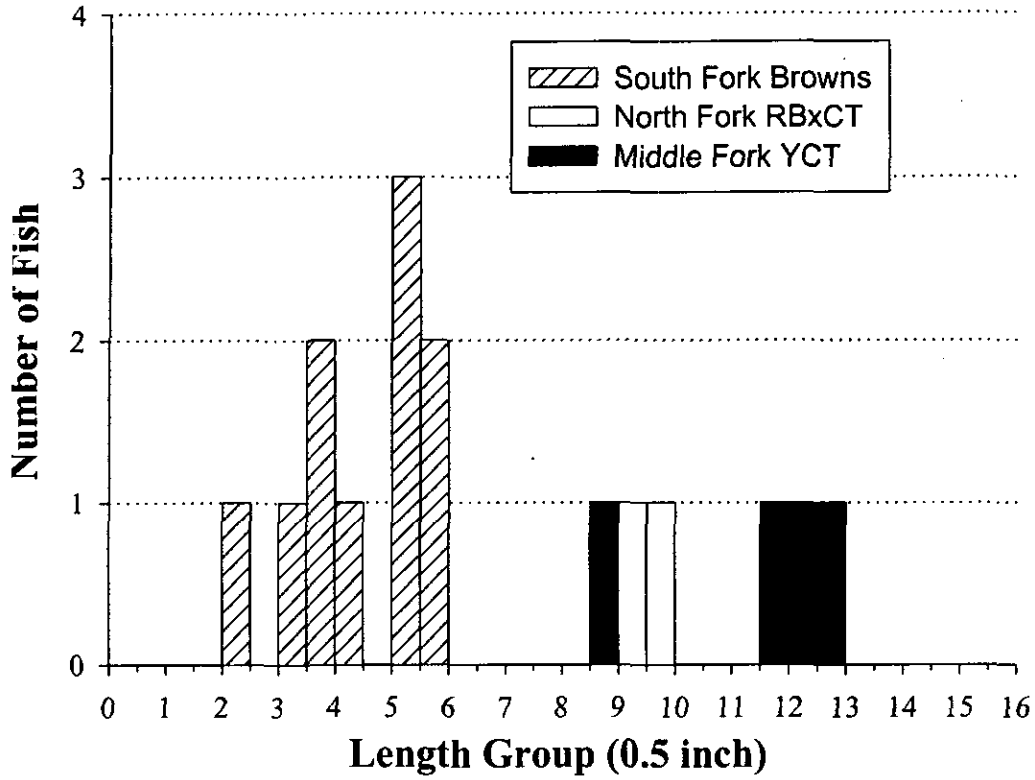

Figure 76. Length frequencies for brown trout captured in the South Fork, hybrids between rainbow trout and cutthroat trout (RBxCT) captured in the North Fork, and Yellowstone cutthroat trout (YCT) captured in the Middle Fork of Squaw Creek during 1999.

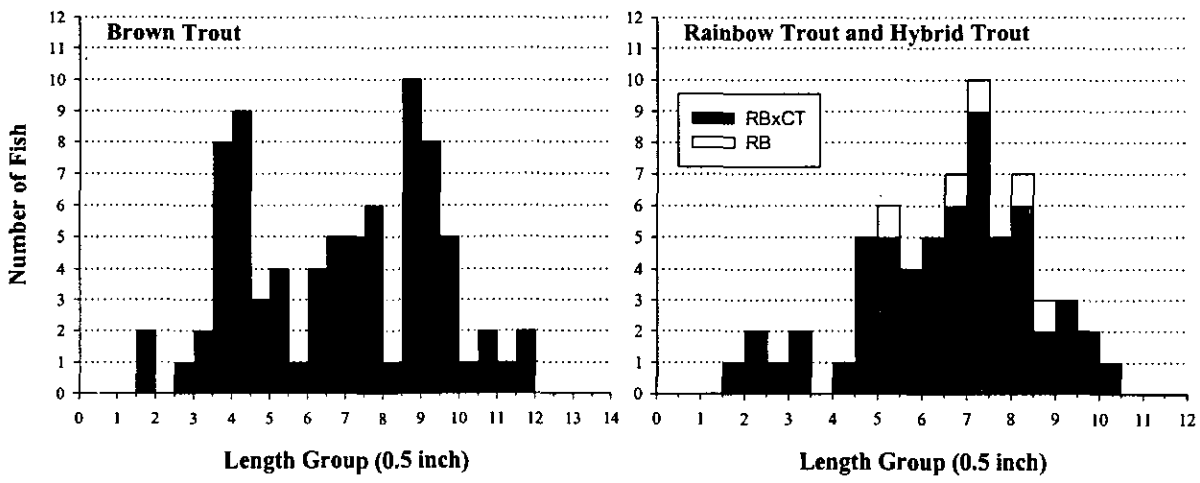

Figure 77. Length frequencies for brown trout (left), rainbow trout (RB) and hybrids between rainbow trout and cutthroat trout (RBxCT) (right) captured in Squaw Creek during 1999.

stream miles 2.0 and 4.0 were about half of those found during the 1996 survey. Both the Middle Fork and North Fork of Squaw Creek were also sampled during the 1996 inventory. No fish were observed or captured by electrofishing in two sample sections at stream miles 0.5 and 1.0 in the North Fork of Squaw Creek. Likewise, no fish were captured in a 450 foot-long section sampled approximately 1.75 miles above the mouth of the Middle Fork of Squaw Creek.

Standard Creek

Standard Creek drains the Gravelley Range and enters the Madison River from the west. It flows through the Beaverhead-Deerlodge National Forest, except for its lower 0.2 miles which flow through BLM and private lands (Figure 1). Standard Creek has two major tributaries, including the South Fork (enters Standard Creek at stream mile 10.7) and Wolverine Creek (enters at stream mile 7.2). The South Fork is only about 1.5 miles long, while Wolverine Creek is about 3.0 miles long. Main Standard Creek is about 13.5 miles long. Standard Creek originates at the top of the Gravelley Range near Black Butte in relatively open meadows and flows through two small ponds. It then flows through open meadows for about four miles before entering relatively steep, coniferous forested lands in its middle reach from about mile 9.0 to mile 5.5. From mile 5.5 down to mile 3.7 the valley bottom becomes wider and the stream gradient lessens and the stream channel meanders through some of this area. At mile 3.7 the stream enters a relatively narrow, steep canyon down to mile 0.5 before it flows into the Madison River valley bottom. Several possible barriers to upstream fish movement were found in Standard Creek. The lowermost was located at about stream mile 0.75 with others seen at stream miles 1.0, 2.2, 2.3, and 4.0.

The Montana FWP fish-planting database indicated that 15,300 undesignated cutthroat trout and two separate groups of young (< 2 inch) rainbow trout (20,000 and 28,000) were planted into Standard Creek in 1931 and 1948 (Appendix G). No other records of fish planting were found for Standard or Wolverine creeks.

Habitat

Four Optic Stowaway® thermographs were placed in Standard Creek and one was placed in Wolverine Creek from July1 to September 19, 1999 (Figure 3). Standard Creek thermographs were located immediately above and about 4.2, 7.0 and 12.0 miles upstream from its mouth at the Madison River. The Wolverine thermograph was placed below the Standard Creek Forest Service road. During the summer average daily temperatures generally ranged from 45 to 52 F in lower Standard Creek (miles 0 and 4.5), and did not exceed 50 F in upper Standard Creek (Figure 78). The range of water temperatures was much lower near the mouth than in the upper portion of the creek. Summer maximum temperatures were above 55 F at all sites. While daily average temperatures were similar in Wolverine Creek, maximum daily temperatures were higher, exceeding 60 F on one occasion (Figure 79).

Reach surveys were conducted throughout Standard Creek from its mouth at the Madison River upstream to stream mile 9.3. The portion of the creek from its mouth upstream 3.8 miles (through the lower canyon reach) was dominated by fast-water riffle habitat types, especially

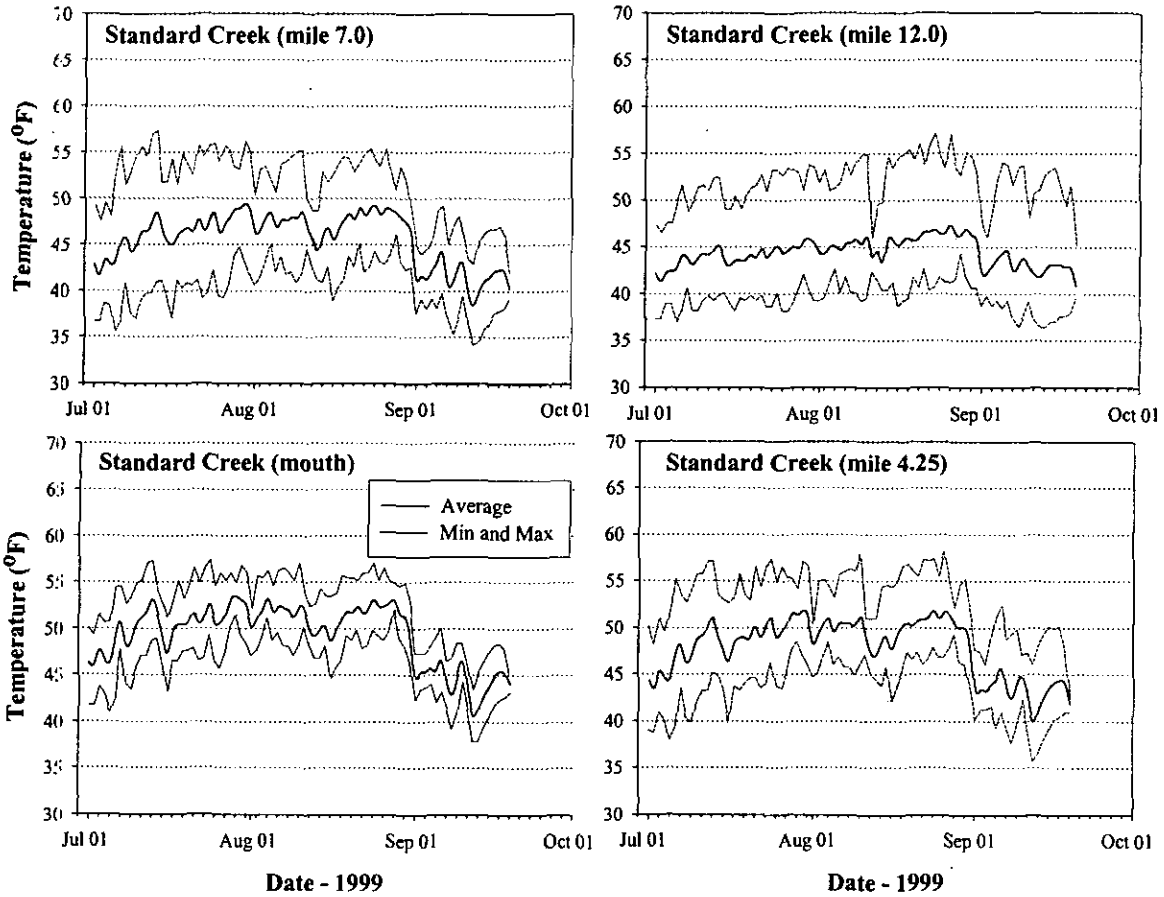

Figure 78. Average, minimum, and maximum daily water temperatures recorded at four locations (stream mile) in Standard Creek during 1999.

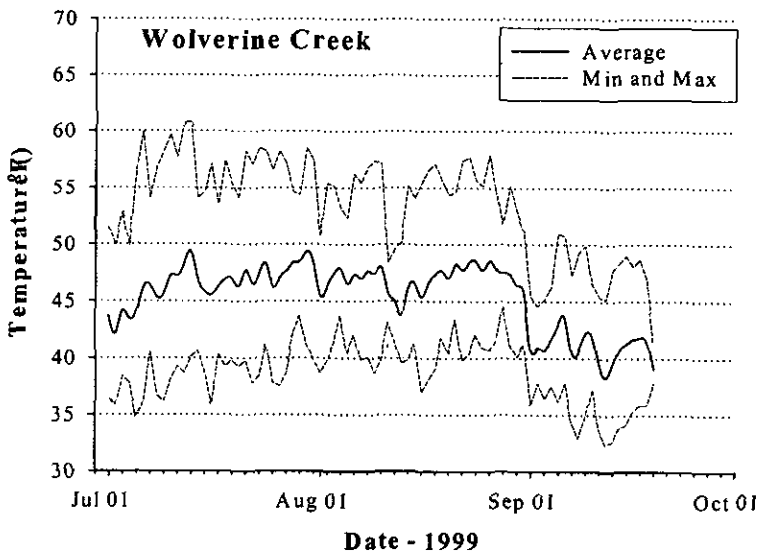

Figure 79. Average, minimum, and maximum daily water temperatures recorded in Wolverine Creek near the Standard Creek Road during 1999.

high gradient riffles and cascades (Table 1). Possible barriers to upstream fish movement were seen at eight different locations through this reach (Figure 4). The lowest one of these was a large logjam located about 0.75 mile above the mouth. From mile 3.8 up to Wolverine Creek, riffles made up about 53% of the habitat units and pools made up 42%. Most riffles in this reach were high gradient riffles and most pools were mid-channel scour pools. A few possible barriers to fish movement were observed in this reach. Two cascades were seen just below Wolverine Creek and another was seen near mile 3.8. From Wolverine Creek up to mile 9.3 pool habitats dominated (49%) and run habitats became more prominent (18%). Riffles made up about 34% of the units in this reach and high gradient riffles dominated riffle types. From Wolverine Creek up the next 0.5 mile, spawning gravels were abundant and in good condition. Surveyors noted the high quality of fish habitat in this portion of the stream and expressed surprise at the relatively low numbers of fish they observed. Several springs entered the channel in this reach and two waterfalls (one dropped three and the other dropped five feet) were seen near stream mile 8.3.

A detailed habitat survey was conducted only at stream mile 6.0. Cobble material dominated the streambed (Table 2). Woody debris was common, but not abundant, in the channel and none of this woody debris crossed the entire wetted channel. Spawning habitat was very abundant in this survey section. Instream and bank cover were ranked as moderate (Table 3). Bank stability was moderate and pool quality was ranked as low-to-moderate. Riparian use was rated as relatively light. Pools made up a relatively small proportion of habitat units and habitat length (Table 4). The average width was 18.8 feet. Average water depth was 8.2 inches.

Fish Distribution and Abundance

Rainbow trout dominated the catch in the two lower sample sites up to about stream mile 1.0 where the stream was contained in a steep canyon and several waterfalls were observed. A single brown trout was captured at stream mile 0.5 (Appendix D). Fish identified as cutthroat trout and mottled sculpins were found above the canyon area up to mile 8.5 in main Standard Creek and mile 1.5 in Wolverine Creek (Figure 80 and Appendix D). Relative catches of cutthroat trout were highest at stream miles 6.0, 2.5, and 3.0 (Figure 80 and Appendix D). No fish were captured in any sample section in Standard Creek above stream mile 8.5 or in sample sections at stream miles 5.5 or 7.0. Nor were any fish captured in sample sections at stream miles 0.4 or 2.0 in Wolverine Creek. We believe that no fish inhabited Wolverine Creek above stream mile 2.0. No sampling was done in the South Fork. However, our observations indicated that low stream flow and high channel gradient made it unlikely that this stream could support fish.

Genetic sampling indicated that the cutthroat trout captured in Standard Creek were hybrids between westslope and Yellowstone cutthroat trout with westslope cutthroat genes dominant. Fish sampled in Wolverine Creek were also hybrids; however, Yellowstone cutthroat genes were dominant in these fish (Table 5). It is likely that Yellowstone cutthroat trout were planted into Wolverine Creek, although there are no records of any plants of Yellowstone cutthroat trout into Wolverine Creek in the Montana FWP fish plant database (Appendix D).

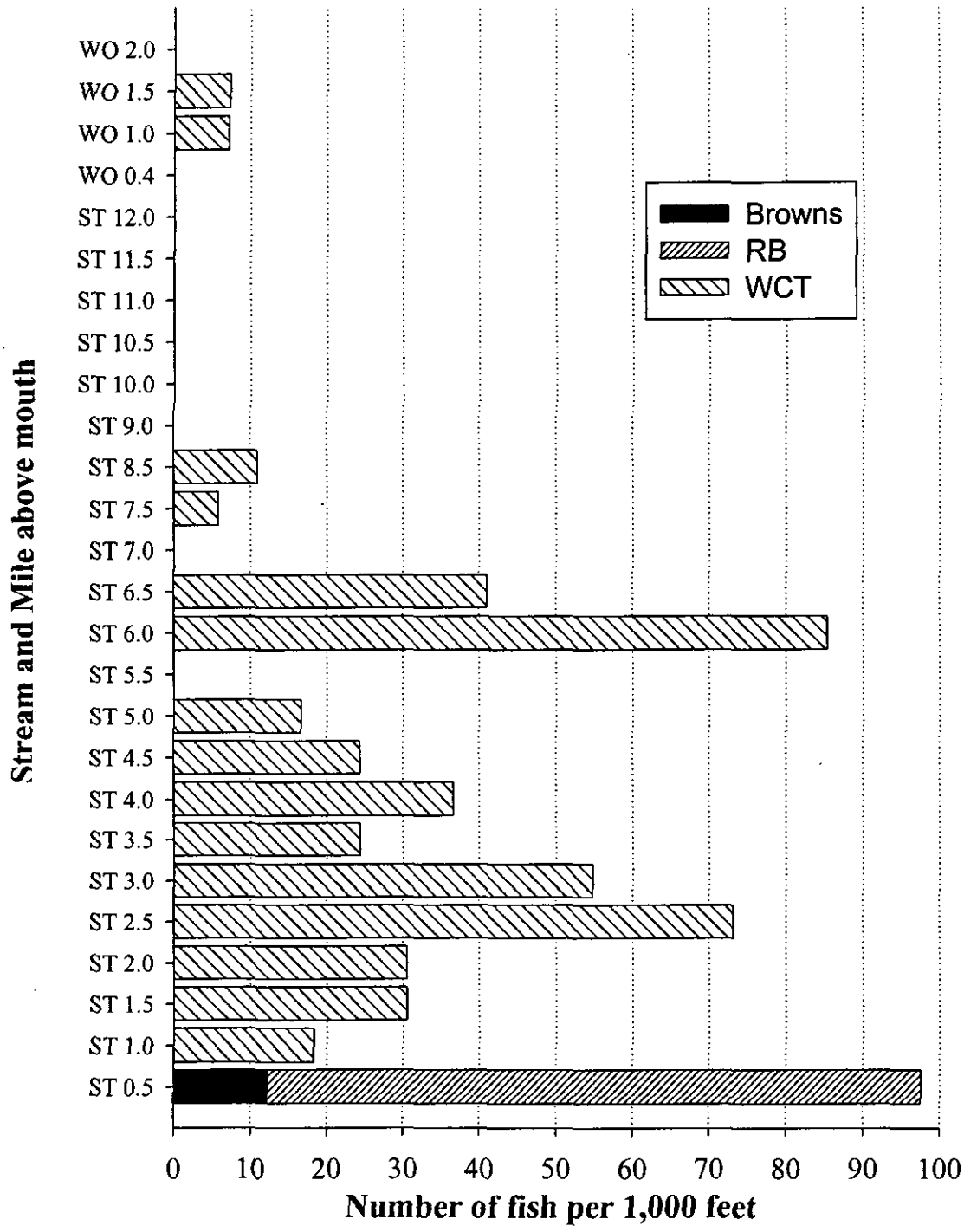

Figure 80. Catch of brown, rainbow, and westslope cutthroat trout (WCT; these were hybridized with Yellowstone cutthroat trout) 3.0 inches and longer per 1,000 feet of stream length in Standard (ST with stream mile) and Wolvernine (WO with stream mile) during the summer of 1997. All sites shown on y-axis were sampled and zero values indicate no fish were captured at these sites.

A depletion estimate made near mile 6.0 captured no fish on a second electrofishing pass (Appendix D). All captured fish were 6.0 inches and longer and a total of 14 were captured in a 164-foot long section. The estimated number of fish per 1,000 feet of stream length was 86 fish.

Fish Length and Weight

The single brown trout captured at mile 0.5 in lower Standard Creek was 5.1 inches long, while the 15 rainbow trout averaged 5.7 inches long (range 1.3 – 10.4; Appendix F and Figure 81).

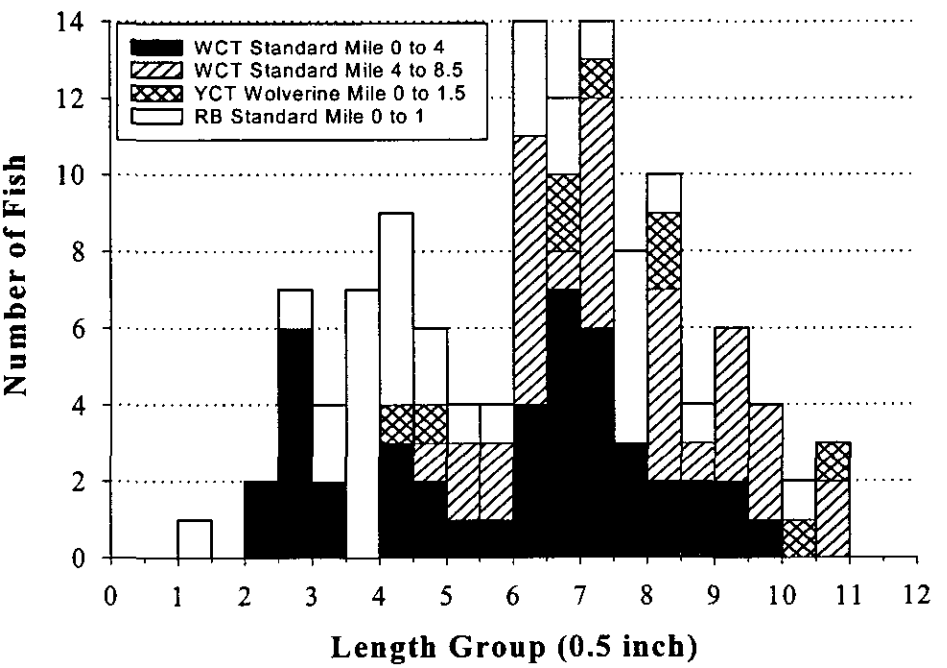

Figure 81. Length frequency histograms for rainbow (RB), westslope cutthroat (WCT), and Yellowstone cutthroat (YCT) trout sampled in Standard and Wolverine creeks during 1997. Westslope cutthroat trout lengths were segregated to those captured in the lower (mile 0 to 4.0) and upper (mile 4.0 to 8.5) reaches of Standard Creek.

Cutthroat trout averaged from about five to six inches in lower sections (mile 1.0 up to 2.5), six to seven inches in the middle sample sample sections (mile 3.0 to 4.5), and seven to nine inches in the upper sample sections (mile 5.0 to 8.5; Appendix F). Cutthroat trout smaller than 4.0 inches were only captured from mile 1.0 to 4.0. The length frequency distributions of captured fish also illustrate the presence of more larger cutthroat trout in the upper portion of the drainage (Figure 81).

Comparison to Previous Sampling

Previous sampling in Standard Creek on September 15, 1988 near stream mile 5.0 estimated about 76 cutthroat trout (SE: 4.5) occupied a 300-foot sample section (J. Brammer, Montana

FWP, Dillon, MT, files). Of these 76 cutthroat trout an estimated 19 were 6 inches and longer (SE: 1.0). Expanding this estimate to calculate the number of cutthroat trout per 1,000 feet of stream length results in estimates of 251 cutthroat trout 3.0 inches and longer, and 63 cutthroat 6.0 inches and longer. The estimated total number of fish in 1988 in this section was much higher than the estimate we made for a section near stream mile 6.0 in 1997 (251 versus 86 per 1,000 feet), but the number of cutthroat trout 6.0 inches and longer was slightly lower in 1988 than in 1997 (63 versus 86). The average length of cutthroat trout captured in this sample section was 5.2 inches (range: 3.2-9.1). In 1997 we captured cutthroat trout that were longer than those captured in 1988 near the same location (Appendix F).

Tolman Creek

Tolman Creek is a small stream draining the Madison Range. The stream flows through a narrow, high gradient canyon in its upper reaches. After leaving the Madison Range, Tolman Creek encounters the Cedar Creek alluvial fan and subsequently loses surface flow. A single pass electrofishing effort was made at stream mile 3.5. No fish were observed or captured in the 269 foot-long sample section. Based on this sampling, Tolman Creek appears fishless.

Wall Creek

Wall Creek drains the Gravelley Range and enters the Madison River from the west. It originates and flows through the Beaverhead-Deerlodge National Forest in its upper reaches, while its lower two miles flow through private lands (Figure 1). Wall Creek has two major tributaries, the North Fork Wall Creek that enters main Wall Creek approximately 4.3 miles above its mouth and an unnamed tributary that drains Kelly Reservoir and enters Wall Creek approximately 5.4 miles from its mouth. Wall Creek is approximately 8.7 miles in length. The North Fork is approximately 2.0 miles long. Wall Creek originates at the top of the Gravelley Range and flows through interspersed narrow stringer-type meadows and dense coniferous forests in a relatively confined valley. A 30-foot waterfall that is a barrier to upstream fish movement is located at about stream mile 5.0 (Figure 4). Once Wall Creek leaves the National Forest (at about stream mile 3.1) the valley opens up and the vegetation changes to a shrub/grassland type. One 8-foot high and another 6-foot high waterfall barrier were found near the National Forest boundary. There is an irrigation diversion located just above the National Forest boundary. Wall Creek then flows into an old beaver complex beginning at about stream mile 2.3 that continues downstream for almost 0.6 miles. Wall Creek then flows through a steep, narrow canyon with several cascades and small waterfalls that may be barriers to upstream fish movement, before entering the Madison River. Two concrete weirs span Wall Creek just above its mouth and the lower weir was diverting all remaining flow out of Wall Creek on July 8, 1997. The North Fork flows through steep, coniferous forest within the National Forest.

The Montana FWP fish-planting database indicated that 11,900 undesignated cutthroat trout were planted into Wall Creek in 1931 (Appendix G). No other fish planting records for the Wall Creek streams were found.

Habitat

An Optic Stowaway® thermograph was placed in Wall Creek near the National Forest boundary from July 10 to October 6, 1997 (Figure 3). During the summer daily temperatures generally averaged from 50 to 55°F, with maximum daily temperatures never going above 65°F (Figure 82).

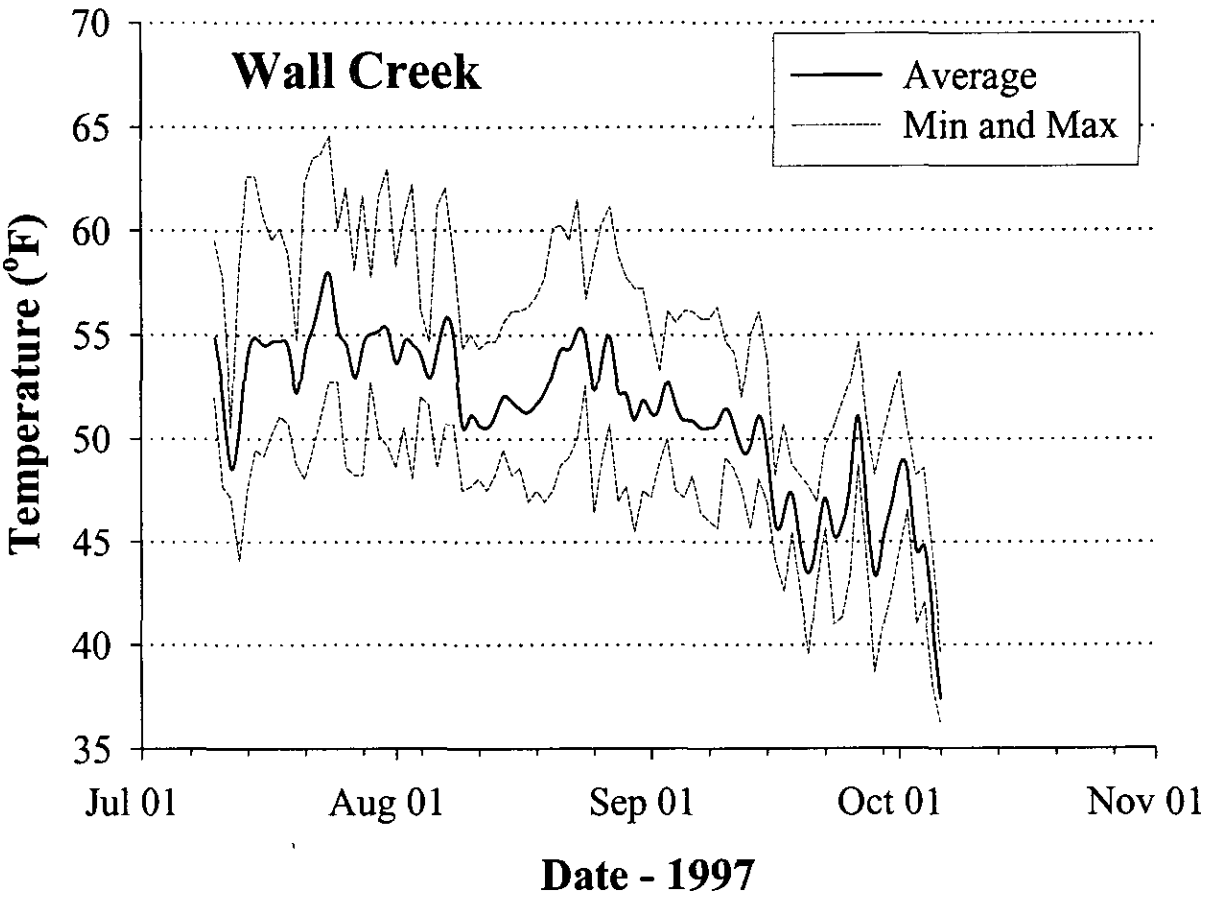

Figure 82. Average, minimum, and maximum water temperatures measured in Wall Creek near the Forest Service boundary during the summer 1997.

Five thermographs were place in Wall Creek from stream mile 0.5 up to mile 6.0, and in the North Fork near its mouth, from July 1 to September 27, 1999 (Figure 3). Water temperatures were relatively consistent throughout the Wall Creek drainage in 1999 with slightly higher temperatures recorded at the lower sites (Figure 83).

A reach survey was conducted in Wall Creek from its mouth at the Madison River upstream about 5.0 miles. This reach survey was broken into 2 segments (Appendix A). Riffle habitat types, consisting primarily of high gradient riffles, dominated the lower 3.1-mile segment

(comprising 64% of the habitats), from the Madison River up to the National Forest boundary (Table 1). Pools (28%) and runs (8%) were also present. Riffles and pools made up nearly equal proportions of the number of habitat units of the upper reach, from mile 3.1 to 5.0 (48 and 41%, respectively), with runs comprising only 11% of the units (Table 1). Mid-channel dammed and mid-channel scour pools dominated pool types in the lower 3.1 miles, while plunge and mid-channel dammed pools dominated in the upper 2.0 miles.

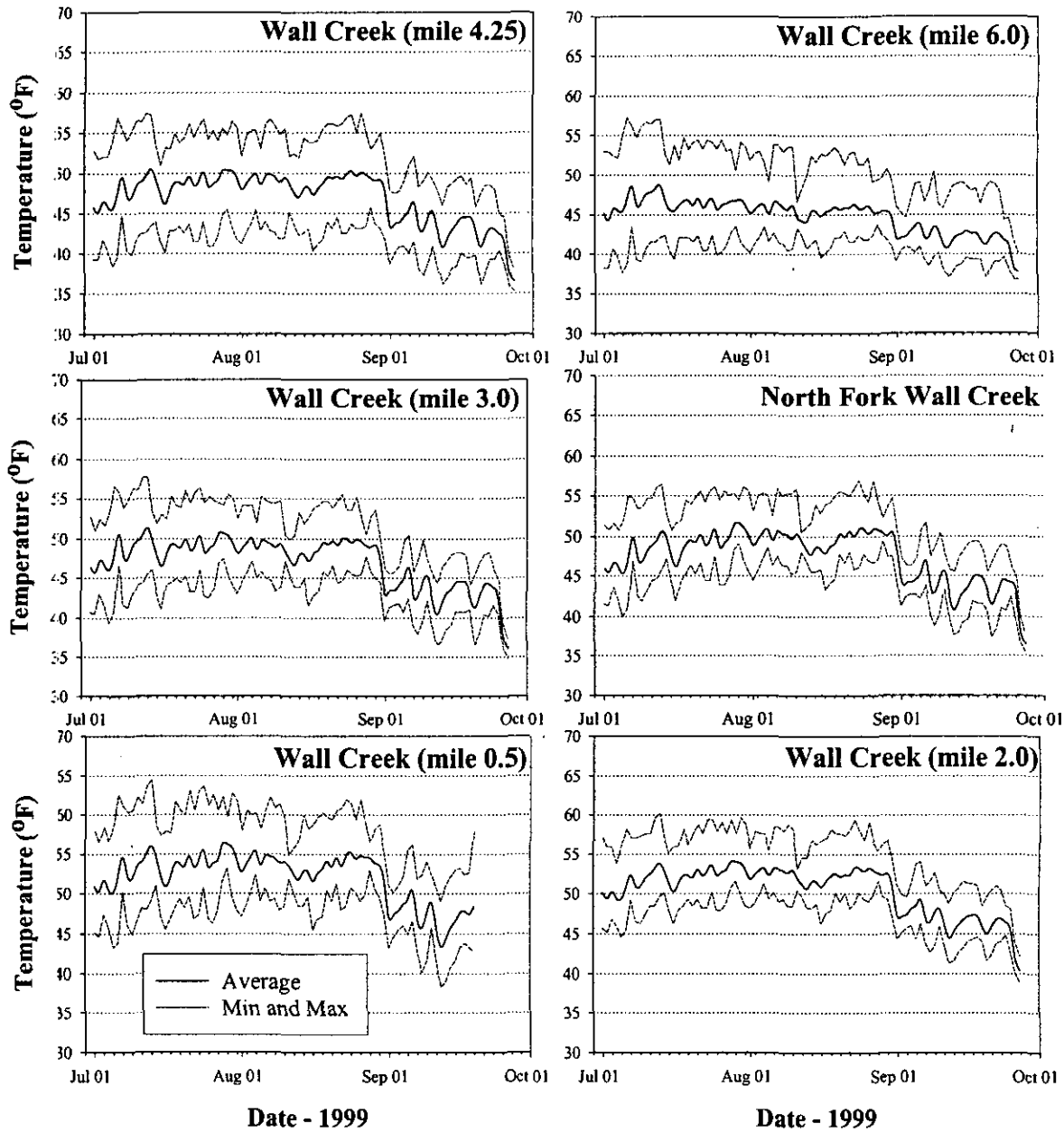

Figure 83. Average, minimum, and maximum daily water temperatures at five sites in Wall Creek and one site in the North Fork of Wall Creek measured during the summer of 1999.

A detailed habitat survey was conducted at mile 3.0 in Wall Creek. The streambed was predominated by large (boulders and cobble) particles (Table 2). Woody debris was extremely abundant, but little of this debris extended across the channel. Spawning habitat was somewhat limited, but was probably adequate. Instream and bank cover, bank stability, and pool quality were all extremely high, and impacts to riparian habitats were very low (Table 3). Average wetted width was 5.4 feet and average water depth was 9.1 inches (Table 4).

Fish Distribution and Abundance

Brown and rainbow trout were found in the lower portion of Wall Creek, at stream miles 0.5. Only rainbow trout were found from at stream miles 1.0 and 1.5, while only westslope cutthroat trout were found from stream mile 2.5 to 4.5 (Figure 84 and Appendix D). No fish were observed or captured at stream miles 2.0, 5.0, 5.5 and 6.0. The barrier falls near stream mile 5.0 appeared to be prohibiting the dispersal of fish into the upper drainage, including the Kelly Reservoir tributary.

Genetic status of this population based on a sample of eight westslope cutthroat trout captured above the National Forest boundary in 1995 was uncertain (a single allele indicated the presence of Yellowstone cutthroat trout genetic material in this sample; Table 5; letter from R. Leary to J. Brammer date April 6, 1998). No evidence of alleles characteristic of Yellowstone cutthroat trout was found in a subsequent sample of three westslope cutthroat trout from main Wall Creek and six from the North Fork Wall Creek in 1997 (Table 5; letter from N. Kanda and R. Leary to B. Shepard dated November 2, 1998). However, due to a freezer malfunction, diagnostic loci between westslope cutthroat trout and rainbow trout could not be analyzed from this sample. Additional PINE's genetic sampling of seven fish from Wall Creek in 1999 found that a single allele characteristic of rainbow trout; however, no other rainbow trout diagnostic alleles had evidence of rainbow trout. Additional genetic sampling probably needs to be done to determine if this single allele that exhibits a rainbow characteristic is a deviant allele. This population should probably be treated as a genetically pure westslope cutthroat trout population until additional sampling confirms its genetic status.

Relative abundance of westslope cutthroat trout in main Wall Creek during 1997 was highest just below the mouth of the North Fork at stream miles 3.5 and 4.0 (Figure 84 and Appendix D). In 1999 a sample at mile 3.5 found the relative abundance of westslope cutthroat trout was similar to that observed in 1997 (90 per 1,000 feet in 1999 versus 89 in 1997). In 1997 the relative abundance of westslope cutthroat trout was similar at miles 2.5, 3.0 and 4.5. Westslope cutthroat trout were present in the lower half-mile portion of the North Fork Wall Creek, but at relatively low abundance. No fish were captured at stream mile 0.5 in the North Fork. Westslope cutthroat trout were seen spawning in main Wall Creek on July 9, 1997 in good spawning habitat located between the mouth of the North Fork and the barrier falls at stream mile 5.0.

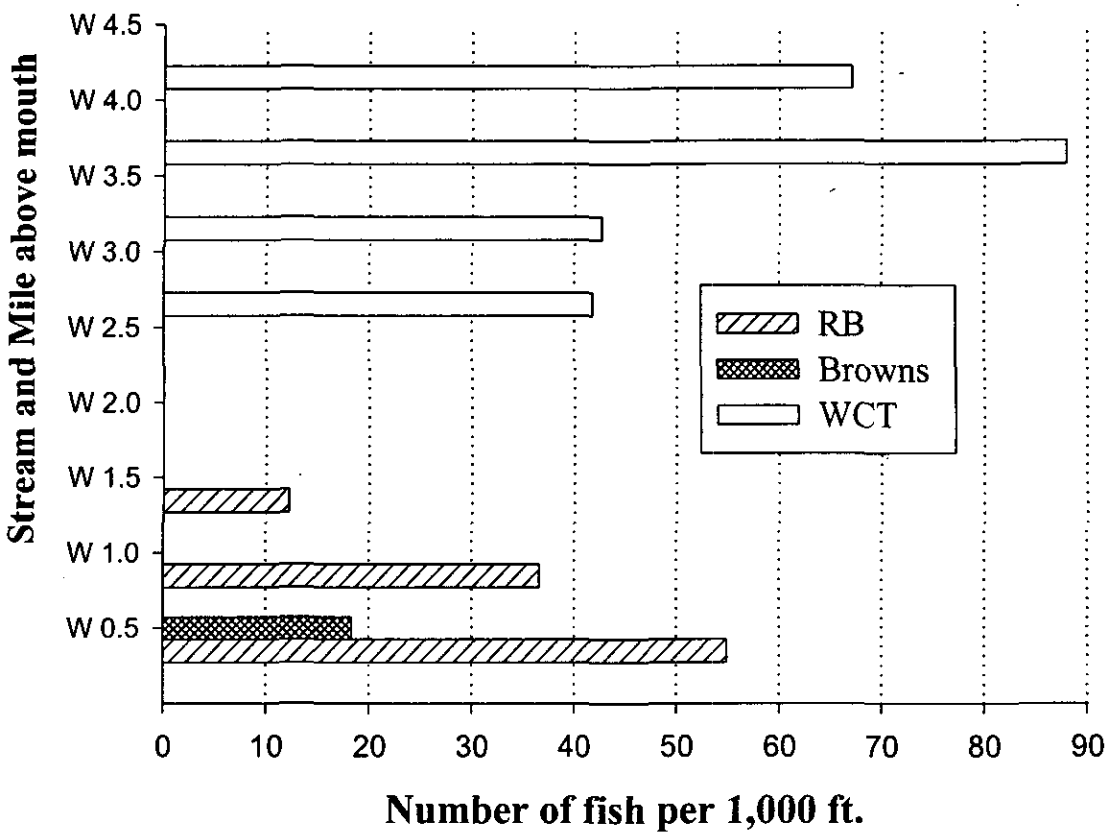

Figure 84. Catch of rainbow (RB), brown, and westslope cutthroat (WCT) trout per 1,000 feet of stream length in Wall Creek ("W" and stream mile) and North Fork Wall Creek ("NF" and stream mile) by stream mile during 1997. All sites along y-axis were sampled and zero values indicate no fish were captured.

A depletion population estimate was made in a 331 foot-long sample section of Wall Creek at stream mile 3.0 (Appendix E). Only westslope cutthroat trout were captured and they ranged in length from 1.9 to 8.7 inches. The 331 foot-long sample section supported an estimated 20 (SE: 0.7) westslope cutthroat trout 3.0 inches and longer. Nine of these fish (SE: 0.5) were between 3.0 and 5.9 inches long and 11 (SE: 0.8) were between 6.0 and 11.9 inches (Appendix E). This estimate translates to an estimated 61 westslope cutthroat trout per 1,000 feet of stream length.

Fish Length and Weight

The few brown trout captured in lower Wall Creek were 4.0 to 5.0 inches long (Appendix F). The captured rainbow trout ranged from 3 to 8.5 inches. Most of the smaller (< 3.5 inch) westslope cutthroat trout captured in the Wall Creek drainage were either captured at the lower portion of their distribution (mile 2.5 to 3.0) or in the lower 0.5 mile of the North Fork (Figure

85). The length frequency distribution indicated that age 0 westslope cutthroat trout ranged from 1.5 to 3.5 inches, age 1 fish ranged from 3.5 to 5.0, age 2 fish from 5.5 to 6.5, and age 3 and older were probably 7.0 inches and longer (Figure 85). Average lengths of captured westslope cutthroat trout increased in an upstream direction (Appendix F).

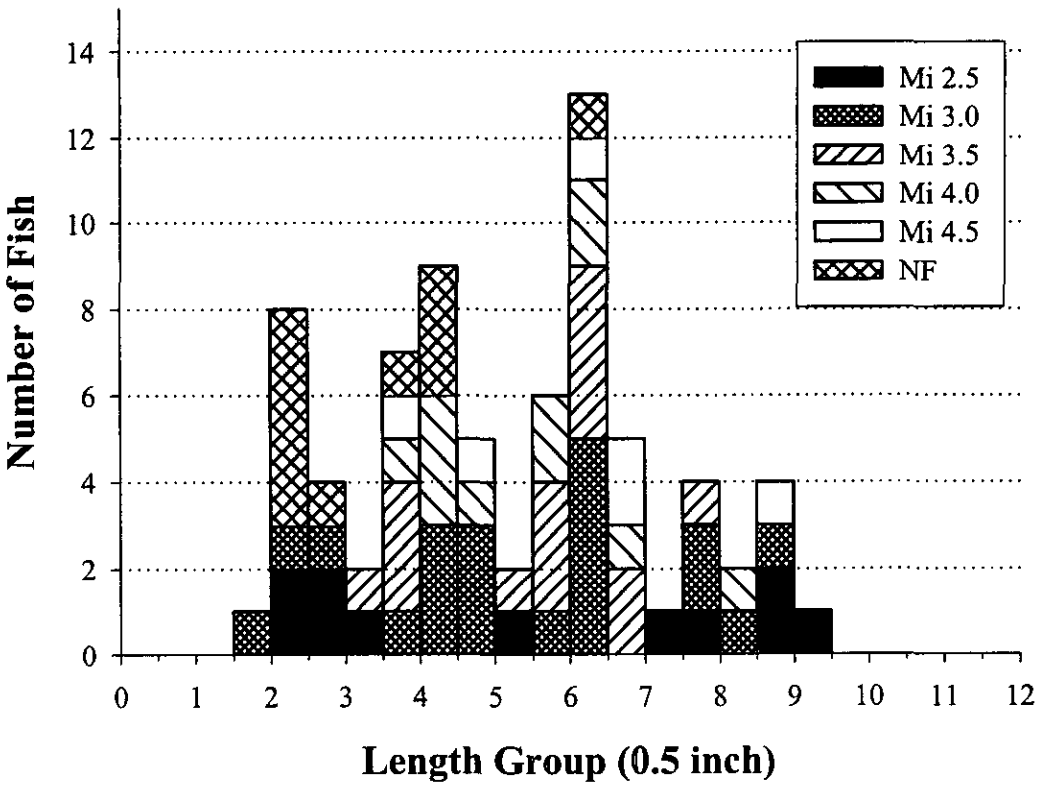

Figure 85. Length frequency histogram for westslope cutthroat trout captured in Wall Creek (by stream mile) and in the North Fork Wall Creek ("NF") during 1997.

Comparison to Previous Sampling

These results were similar to results from sampling done in a single 500 foot-long section sampled near stream mile 3.0 on September 14, 995 (J. Brammer, Montana FWP, Dillon, MT; files). Brammer estimated that there were 72 westslope cutthroat trout 3 inches and longer per 1,000 feet of stream. No westslope cutthroat trout less than 3.0 inches were captured and the average length was 6.3 inches (range: 3.4 - 9.1).

Wigwam Creek

Wigwam Creek drains the Gravelley Range and enters the Madison River from the west. It originates and flows through the Beaverhead-Deerlodge National Forest in its upper reaches, while its lower 5.5 miles flow through private lands (Figure 1). Wigwam Creek has three major named tributaries, Buffalo Creek which enters Wigwam Creek about 7.9 miles above its mouth, Haypress Creek which enters at about stream mile 4.9, and Canyon Gulch which enter at about stream mile 4.6. Wigwam Creek is approximately 9.8 miles in length. Buffalo Creek is approximately 3.3 miles long and has a major tributary, Arasta Creek, which enters Buffalo Creek about 0.9 miles above Buffalo's confluence with Wigwam Creek. Arasta Creek is about 3.7 miles long. Canyon Gulch is about two miles long and was too steep to support fish. Upper Buffalo Creek (above mile 1.6), a short portion of Arasta Creek (mile 1.0 to 1.4), and Wigwam Creek from mile 4.3 to 5.6 flow through BLM administered lands. Wigwam, Arasta, and Buffalo creeks originate at the top of the Gravelley Range and flow through moderate gradient benches and steep narrow valleys surrounded by a mixture of steep grasslands and coniferous forests interspersed with aspen stands. Lower Buffalo Creek (below stream mile 1.3) and Wigwam Creek from about stream mile 9.0 down to 4.0 flow through a very narrow steep valley with conifers on the south side of the valley (north facing slope) and steep open grasslands on the north side. A waterfall that is probably a barrier to upstream fish movement is located at about stream mile 4.7, just above the confluence of Canyon Gulch (Figure 4). Once Wigwam Creek leaves the lower BLM section (at about stream mile 4.3) it meets the main Madison River valley bottom its gradient lessens and water is diverted for irrigation.

The Montana FWP fish planting database indicated that 2,100 six inch rainbow trout were planted into Wigwam Creek in 1946, 20,000 rainbow trout fry were planted in 1948, and 10,000 rainbow trout fry were planted in Arasta Creek in 1948 (Appendix G). No other records of fish planting in streams of the Wigwam drainage were found.

Habitat

An Optic Stowaway® thermograph was placed in Wigwam Creek at the County Road crossing about 0.5 miles above its mouth July 15 to October 11, 1998 (Figure 3). From mid-July through the rest of the summer daily temperatures generally averaged from 55 to 62°F, however, temperatures may have been higher earlier in the summer prior to the installation of the thermograph (Figure 86). The maximum-recorded temperature was near 70° F, but this occurred immediately following the deployment of the thermograph. Maximum temperatures remained near 65° F the remainder of the summer. In 1999 three thermographs were placed in Wigwam Creek at stream miles 0.5, 4.0, and 8.0 (Figure 3). A thermograph was placed at mile 2.5 in Arasta Creek and another thermograph was placed at mile 2.25 in Buffalo Creek (Figure 3). All thermographs were deployed on July 1 and retreived in early October 1999. Due to extremely low flows caused, in part, by irrigation withdrawals, the thermograph at mile 4.0 was exposed on August 29 and no temperature records after that date could be used. Maximum water temperatures were recorded about the twelfth of July in Wigwam Creek and reached just over 65 F in at miles 0.5 and 4.0, and only 56 F at mile 8.0 (Figure 87). Water temperatures were much more variable in Buffalo Creek than in either Wigwam or Arasta creeks (Figure 87). The

maximum water temperature in Buffalo Creek reached 70 F on August 26. Maximum water temperatures in Arasta Creek were similar to upper Wigwam Creek.

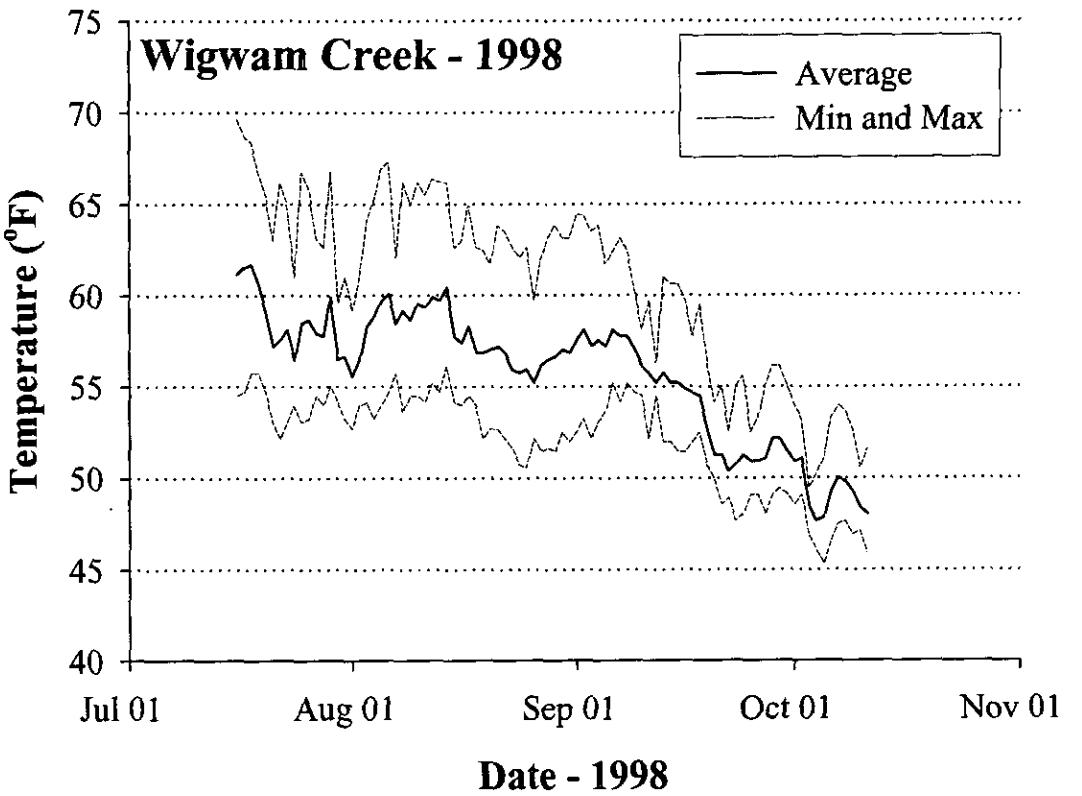

Figure 86. Average, minimum, and maximum daily water temperatures about 0.5 miles above the mouth of Wigwam Creek during the summer of 1998.

Wigwam Creek

A 0.5 mile reach survey was conducted in Wigwam Creek within the lower BLM section, from stream mile 4.3 to 4.8 (Appendix A). Riffle habitat types made up about 47%, pools about 31%, and runs about 22% of the habitat units in this 0.5 mile reach (Table 1). High gradient riffles dominated riffle types, while plunge pools dominated pool types.

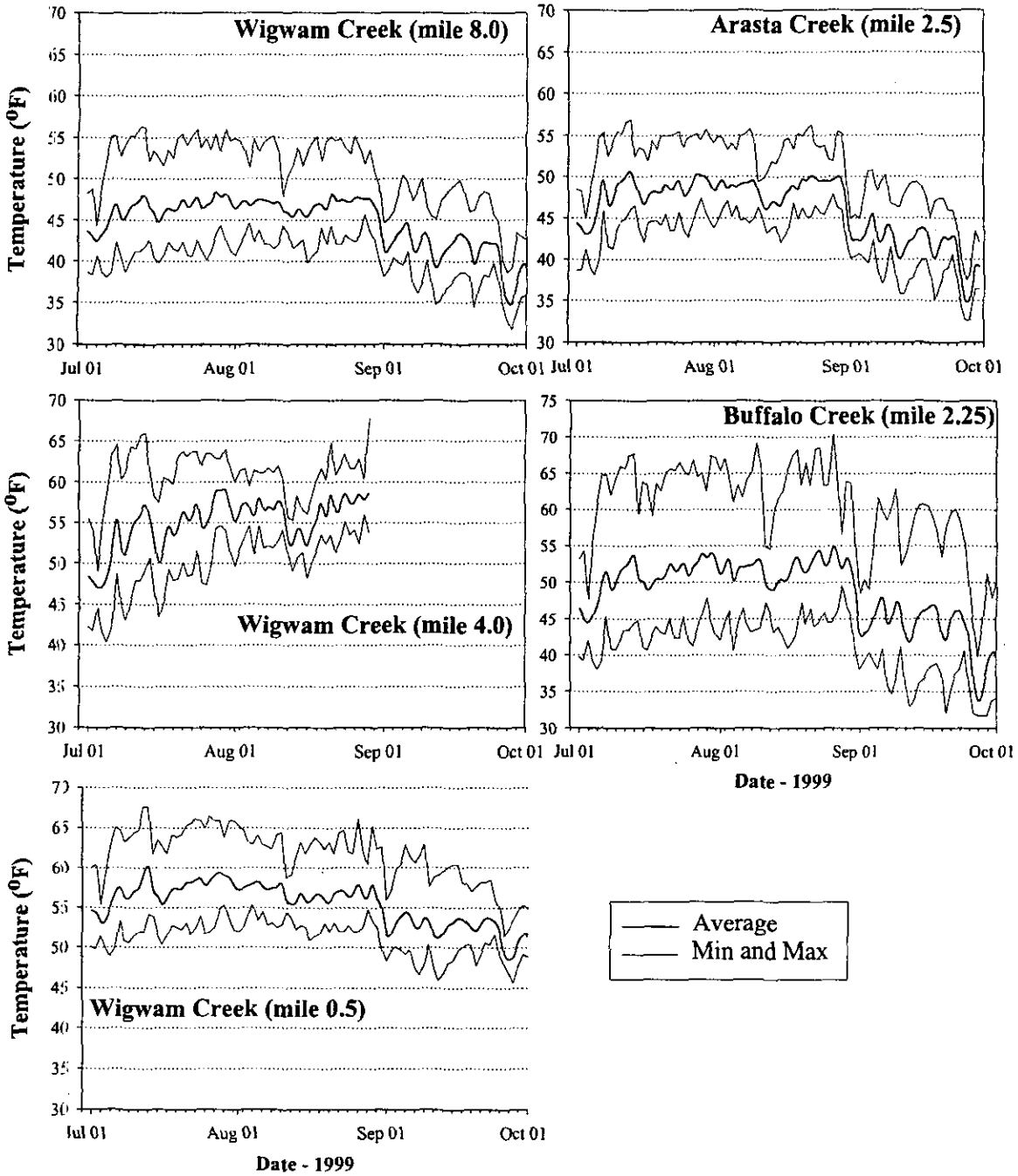

Figure 87. Average, minimum, and maximum daily water temperatures at three sites in Wigwam Creek, a site in Buffalo Creek, and a site in Arasta Creek by stream mile during the summer of 1999.

Buffalo Creek

A detailed habitat survey was conducted at mile 1.5 in Buffalo Creek. The streambed was predominated by cobble-sized particles (Table 2). Woody debris was moderately abundant, but little of this debris extended across the channel. Spawning habitat was also moderately abundant, and was probably adequate. Instream and bank cover, bank stability, and pool quality were all ranked as moderate to low, and impacts to riparian habitats were ranked as moderately high (Table 3). Most riparian impacts were related to livestock grazing. Average water depth was only 3.7 inches, but average maximum pool depth was near 12 inches (Table 4). Average wetted width was about 4.8 feet.

Fish Distribution and Abundance

Only westslope cutthroat trout and possible hybrids between westslope cutthroat trout and either Yellowstone cutthroat or rainbow trout were captured in the Wigwam Creek drainage above mile 4.0. Genetic sampling in 1995 indicated that Arasta and Buffalo creeks supported genetically pure westslope cutthroat trout (Table 5). A sample of fish from Wigwam Creek above stream mile 8.0 was found to be hybridized westslope with Yellowstone cutthroat trout (letter from N. Kanda and R. Leary to B. Shepard dated November 2, 1998). However, due to a freezer malfunction, diagnostic loci between westslope cutthroat trout and rainbow trout could not be analyzed from this sample. These genetic data suggest that westslope cutthroat trout in Buffalo and Arasta creeks may have been pure; however, additional sampling done in 1999 indicated that fish in the upper Wigwam Creek drainage, including Buffalo and Arasta creeks, were hybridized (Table 5). All captured fish were designated as westslope cutthroat trout, but it is likely that these fish were introgressed.

Wigwam Creek

Relative abundance of westslope cutthroat trout in Wigwam Creek was highest near stream mile 8.0, then declined rapidly above this point and no fish were seen or captured above stream mile 9.0 (Figure 88). Abundance of westslope cutthroat trout was relatively low from mile 4.9 up to mile 7.5 and no fish were captured at mile 4.3.

Buffalo Creek

In Buffalo Creek the abundance of westslope cutthroat trout was highest at stream mile 0.5, but no fish were seen or captured at stream mile 1.0 (Figure 88). Westslope cutthroat trout were found in moderate abundance at stream mile 1.5, but then declined to low abundance at miles 2.0 and 2.5. Limited sampling in 1999 found similar relative abundance. A depletion population estimate was made in a 331 foot-long sample section of Buffalo Creek at stream mile 1.5, but no fish were captured on the second pass so the relative abundance displayed for mile 1.5 in Buffalo Creek also represents an estimate (Figure 88). No fish were seen or captured at stream mile 3.0.

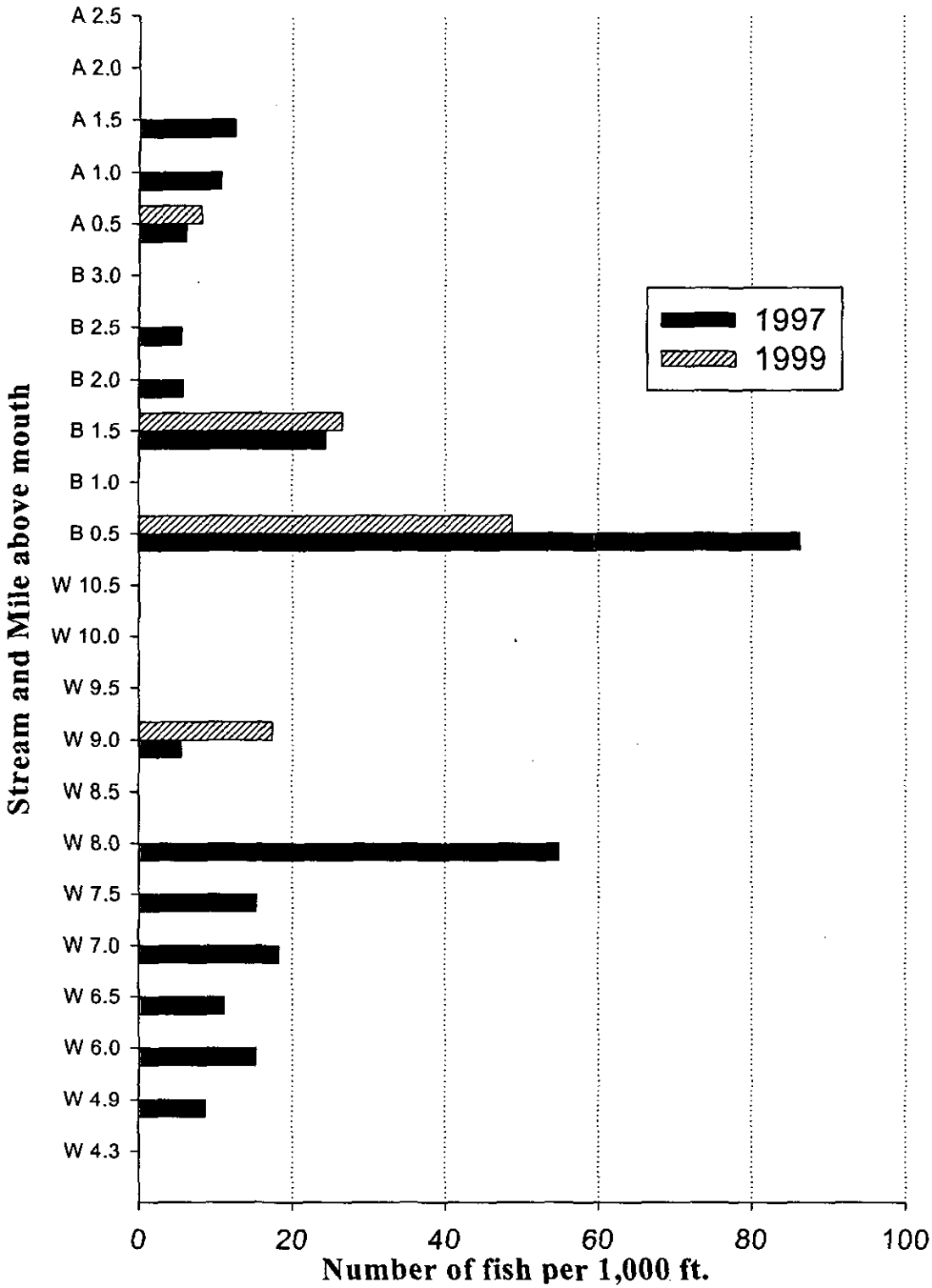

Figure 88. Catch of westslope cutthroat trout 3.0 inches and longer per 1,000 feet of stream length in Wigwam Creek (W with stream mile), Buffalo Creek (B with stream mile), and Arasta Creek (A with stream mile) during the summers of 1997 and 1999. All sites along y-axis were sampled and zero values indicate no fish were captured.

Arasta Creek

In Arasta Creek the abundance of westslope cutthroat trout was low in all sampled sections (Figure 88).

Fish Length and Weight

Captured westslope cutthroat trout ranged from 2.4 to 6.4 inches in Arasta Creek, 2.9 to 7.4 inches in Buffalo Creek, and from 3.1 to 11.9 in Wigwam Creek (Appendix F). Captured fish seldom exceeded 6.0 inches in Buffalo and Arasta creeks, but many fish exceeded 8.0 inches in Wigwam Creek and many of these larger fish were captured in the lower part of the creek (Figure 89). There were no obvious trends in average lengths or length distributions within Wigwam Creek longitudinally up the stream (Appendix F).

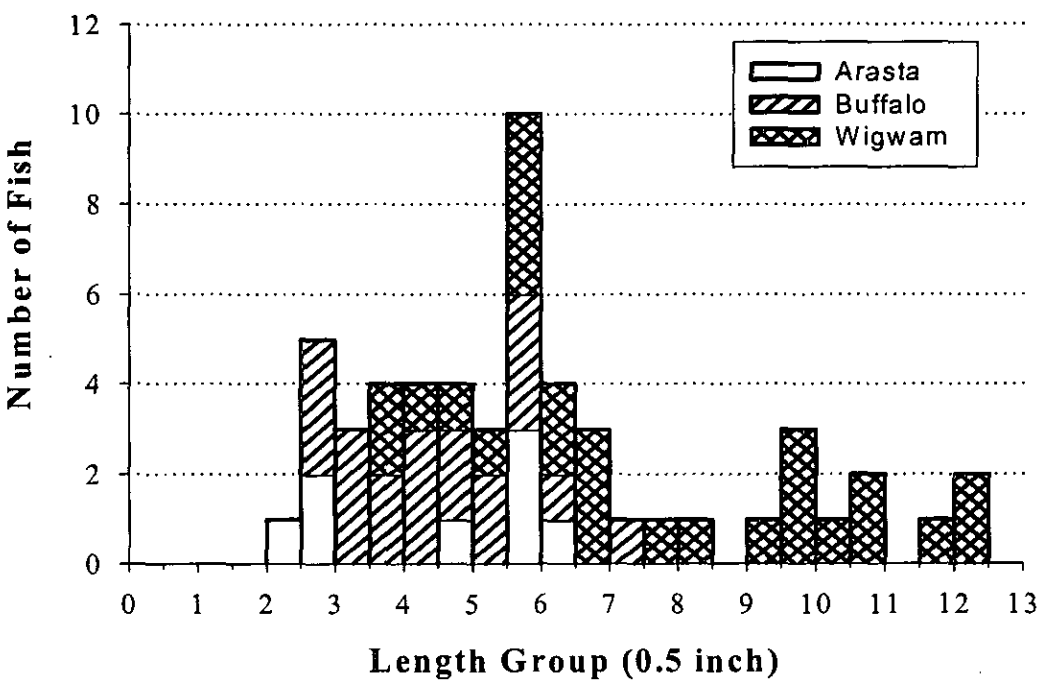

Figure 89. Length frequency histograms for westslope cutthroat trout captured in Wigwam, Buffalo, and Arasta creeks during the summer of 1997.

Comparison to Previous Sampling

A habitat survey of Wigwam Creek upstream from the Forest Service boundary (J. Brammer, Montana FWP, Dillon, MT; files) found that the channel had been impacted with fine sediments that were believed to originate from a breached beaver dam. Improper livestock grazing and past mining tailings were also speculated as reasons for high sediment loads to the stream. Lower Buffalo Creek and Arasta Creek were also surveyed and found to have had some minor livestock impacts. The lower Buffalo Creek channel was moderately well armoured with boulders along its lower end, but the Arasta Creek channel was heavily impacted in the portion of the channel that flows through some sagebrush meadows.

On July 26, 1995 a single westslope cutthroat trout was captured in upper Wigwam Creek (near stream mile 8.5; above Buffalo Creek) in 490 feet of stream (J. Brammer, Montana FWP, Dillon, MT; files). A depletion population estimate conducted in Arasta Creek near stream mile 1.6 estimated a 662 foot-long section contained 12 (SE: 8.1) westslope cutthroat trout 3.0 to 5.9 inches long and 4 (SE: 6.8) 6.0 to 11.9 inches long. Their average length was 5.0 inches. We found a similar relative abundance at mile 1.5 in 1997.

Wolf Creek

Wolf Creek is a 12 mile-long stream draining the Madison Range (Figure 1). Originating in the Lee Metcalf Wilderness Area, Wolf Creek flows through a narrow valley bottom bordered by conifer forest and talus slopes in its upper seven miles. Approximately 4.0 miles above the mouth of Wolf Creek the valley becomes less confined and cottonwood and willow replace conifers in riparian community. Wolf Creek has one tributary, previously unnamed but termed Wedge Creek in this report. Wedge Creek drains the steep ridgeline south of No Man Peak known as the Wedge and enters Wolf Creek at stream mile 6.4. Wedge Creek appears to small to support a resident salmonid population. An active irrigation ditch (Cummings Ditch) is located at stream mile 3.2. At stream mile 4.8 a debris dam creating a 4-foot vertical drop presents a possible barrier to upstream fish migration. No fish were observed or captured above this debris dam (see below). Additionally, a 15 foot-high waterfall barrier is located at stream mile 8.75 at the base of a large landslide (Figure 4).

The Montana FWP fish planting database indicates that 10,000 brown trout were planted on 4/15/46 near the mouth of Wolf Creek (Appendix G). 13,348 additional brown trout were planted the following year and 10,000 rainbow trout were planted on 7/26/48 at the same location.

Habitat

Stream temperature was measured from July 8 through September 25, 1999 in Wolf Creek at the stream's mouth, mile 3.0, mile 5.5, and at mile 8.75 using Onset Optic Stowaway® thermographs (Figure 3). Mean summer temperatures remained relatively cool, ranging from 42.8°F at stream mile 5.5 to 51.3°F at the mouth of Wolf Creek (Figure 90). Stream temperatures fluctuated 1.0 to 21°F daily. Maximum summer temperatures ranged from 48.0°F

at stream mile 5.5 to 67.7°F at the stream's mouth. However, maximum and mean summer temperatures may be lower than recorded at the mouth of Wolf Creek since the thermograph was dewatered for part of August due to extremely low flows caused by irrigation withdrawal.

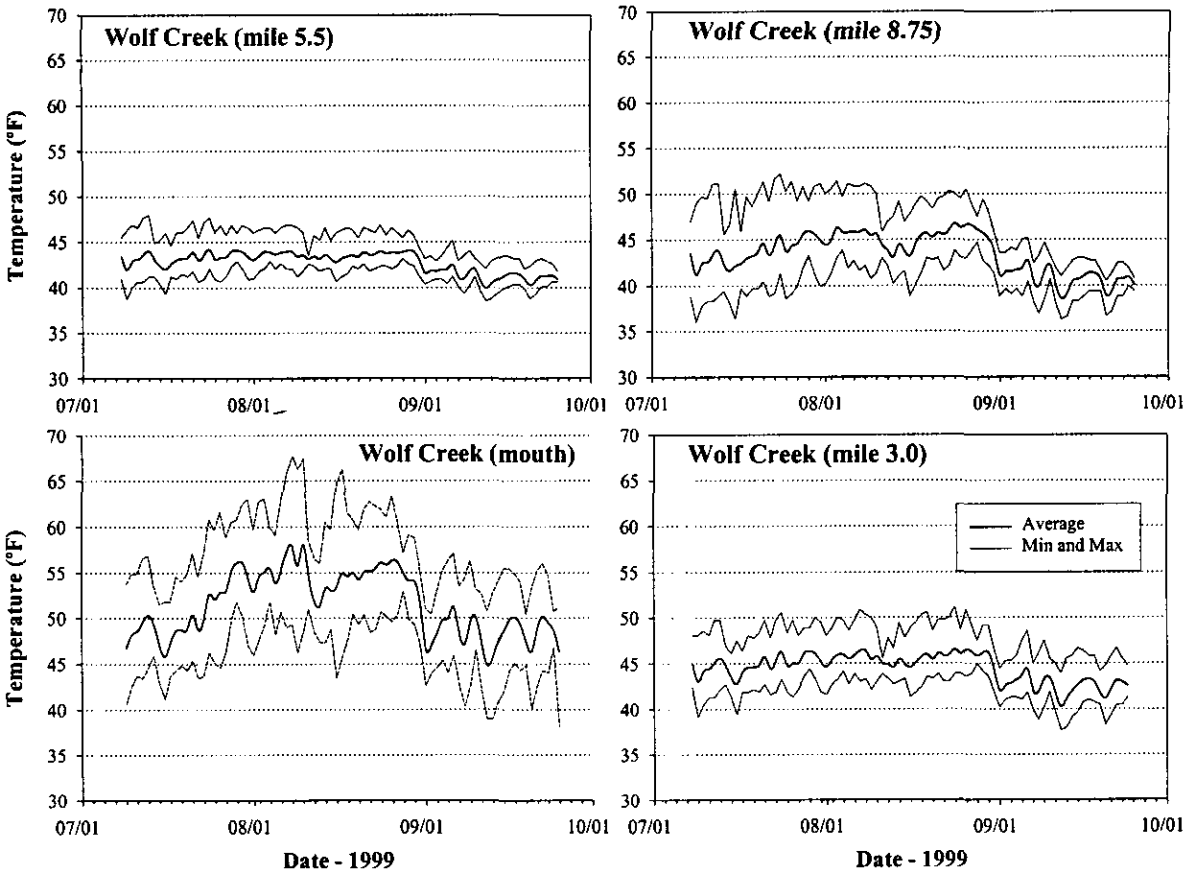

Figure 90. Average, minimum, and maximum stream temperatures at four locations in Wolf Creek during 1999.

A detailed habitat survey was conducted in Wolf Creek at stream miles 2.0, 4.0, and 5.5. At stream mile 2.0 large and small gravel, cobble, and boulder dominated the streambed and were seen in nearly equal proportions (Table 2). Woody debris and spawning habitat were moderately abundant. Instream cover, bank cover, bank stability, and pool habitat all received moderate ratings (Table 3). Riparian use was limited to occasional wildlife browse. At stream mile 4.0 the streambed was dominated by large gravel and cobble substrates (Table 2). Woody debris and spawning habitat were moderately abundant. Instream cover, bank cover, bank stability, and pool habitat all received moderate ratings (Table 3). Riparian impacts appeared heavy due to past livestock grazing. At stream mile 5.5 the streambed was dominated by large gravel and cobble substrates (Table 2). Woody debris was relatively abundant and much of this debris extended across the stream channel. Spawning habitat was abundant and of excellent quality. Instream cover, pool habitat, and streambank stability were all excellent (Table 3). Bank cover

was moderate to excellent. Riparian impacts were moderate due to past livestock grazing. Overall trout habitat appeared excellent at this sample site.

Fish Distribution

Wolf Creek

Brown trout, rainbow trout, and rainbow-cutthroat trout hybrids were captured in Wolf Creek. Brown trout were captured in Wolf Creek from the lowest sample section at stream mile 0.5 upstream through mile 2.5 (Figure 91). Rainbow trout were captured in sample sections 1.0, 1.5, 2.0, 3.0, 3.5, and 4.0 miles above the stream's mouth (Figure 91). A total of 4 rainbow-cutthroat trout hybrids were also captured in Wolf Creek. One rainbow-cutthroat trout hybrid was captured at stream miles 0.5, and 3.5, and two were captured at stream mile 4.5. No fish were observed or captured in sample sections at stream miles 5.5 and 6.5. Relative abundances of brown trout varied widely, ranging from a peak of 98.9 trout greater than 3 inches per 1000 feet of stream at stream mile 1.5 to a low of 2.54 trout greater than 3 inches per 1000 feet of stream at stream mile 2.5 (Figure 91). Relative abundances of rainbow trout were low in Wolf Creek, ranging from 5.1 to 9.8 trout greater than 3 inches per 1000 feet of stream, and generally increased in an upstream direction.

Depletion population estimates were made 2.0, and 4.0 miles above the mouth of Wolf Creek. At stream mile 2.0 the 394 foot-long sample section yielded 6 brown trout, of which 1 was between 3 and 6 inches in length, and 5 were between 6 and 12 inches in length. Since all brown trout were captured on the first pass, we were unable to calculate population estimates and standard errors. The same sample section also supported an estimated 4 rainbow trout (SE: 0.61), of which 1 was between 3 and 6 inches long, and 3 (0.5) were between 6 and 2 inches (Figure 92). At stream mile 4.0, a 404 foot-long sample section yielded an estimated 4 rainbow trout (SE:0.5), of which 3 (SE: 0.5) were between 6 and 12 inches and long, and one was between 12 and 18 inches.

Fish Length and Weight

Brown trout ranged from 1.6 to 13.4 inches in length (Figure 93). Average lengths of brown trout ranged between 8.7 and 9.4 inches except at stream miles 1.5 and 2.5. At stream mile 1.5 an abundance of brown trout in the 3 to 6 inch range caused the average length to decline to 5.6 inches. At stream mile 2.5 a single 12.2 inch-long brown trout was captured. Rainbow-cutthroat trout hybrids ranged from 5.5 to 8.8 inches in length. Rainbow trout ranged from 5.7 to 12.0 inches in length (Figure 93). Average lengths of rainbow trout increased steadily from 6.9 inches at stream mile 2.0 to 9.5 inches at stream mile 4.0.

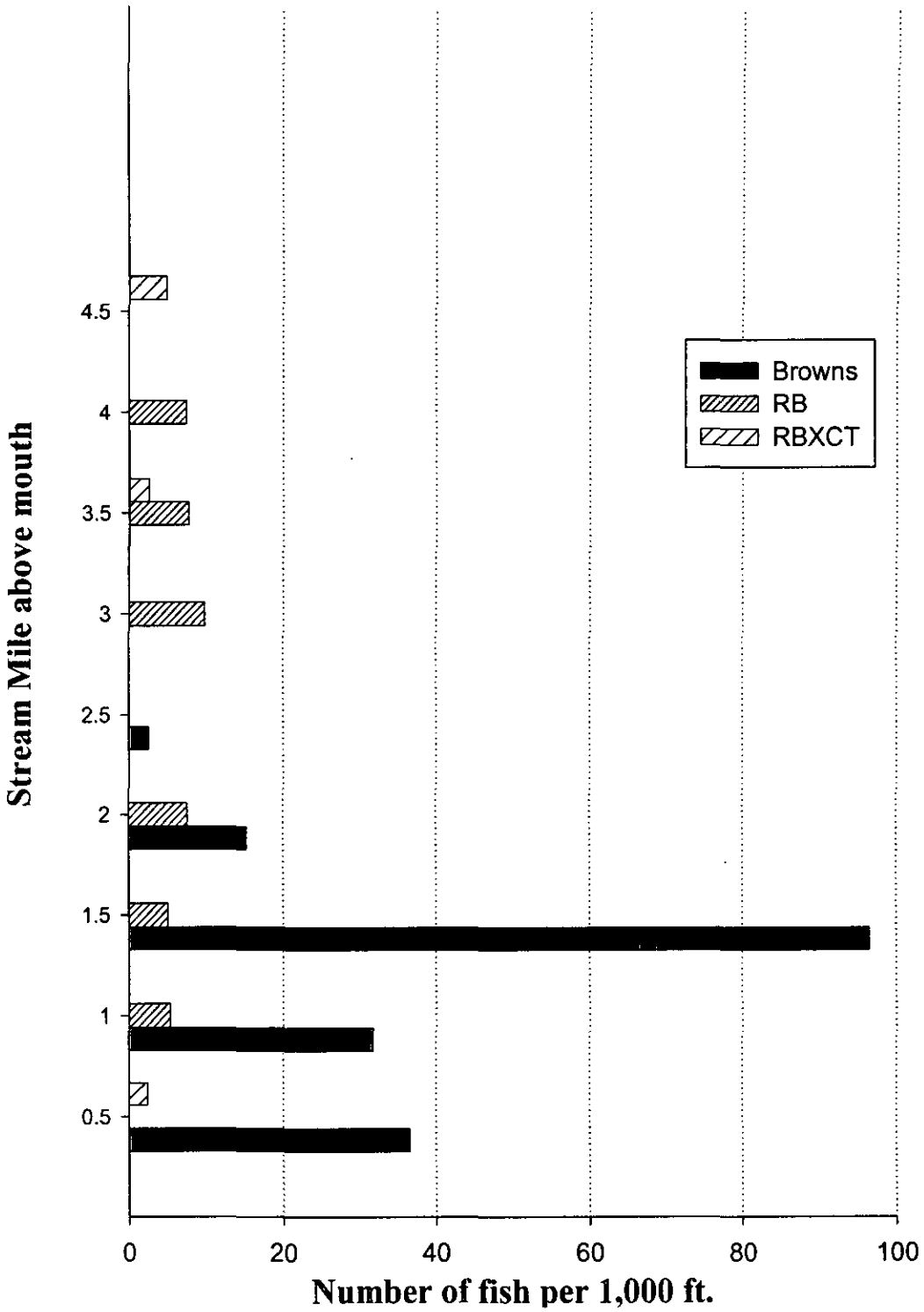

Figure 91. Catch of brown trout, rainbow trout (RB), and hybrids between rainbow trout and cutthroat trout (RBxCT) by stream mile in Wolf Creek during 1999. All sites along the y-axis were sampled and zero values indicate no fish were captured.

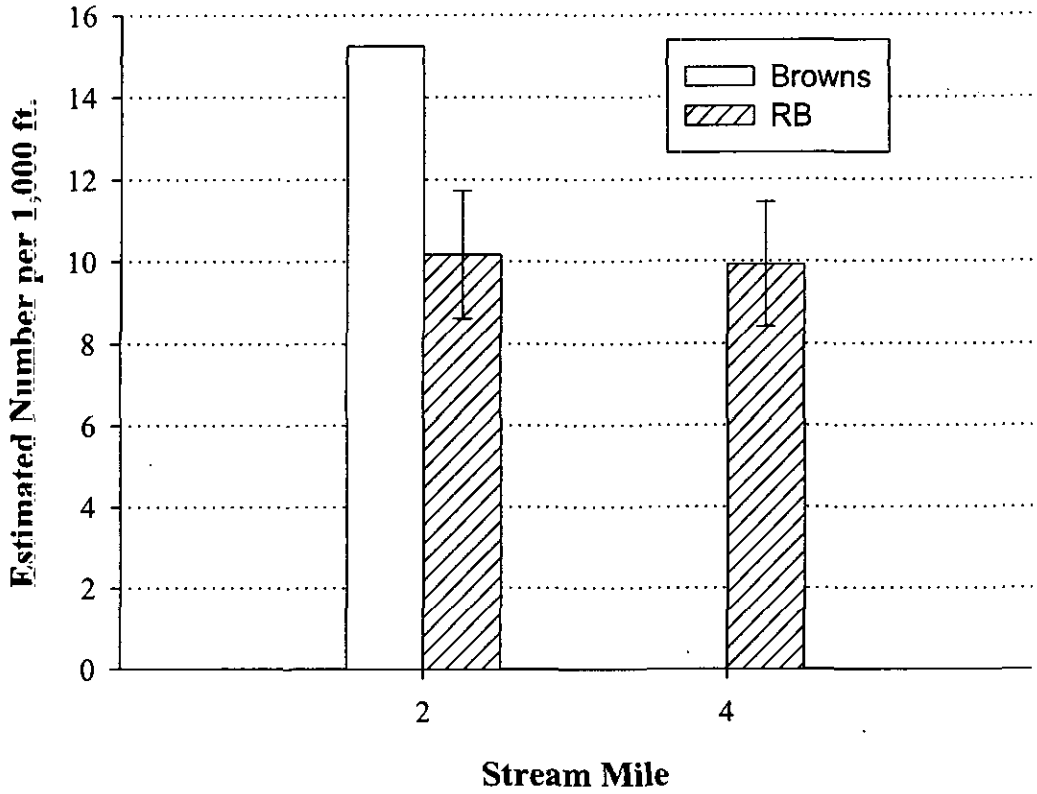

Figure 92. Estimated number of brown trout and rainbow trout (RB) by stream mile in Wolf Creek during 1999.

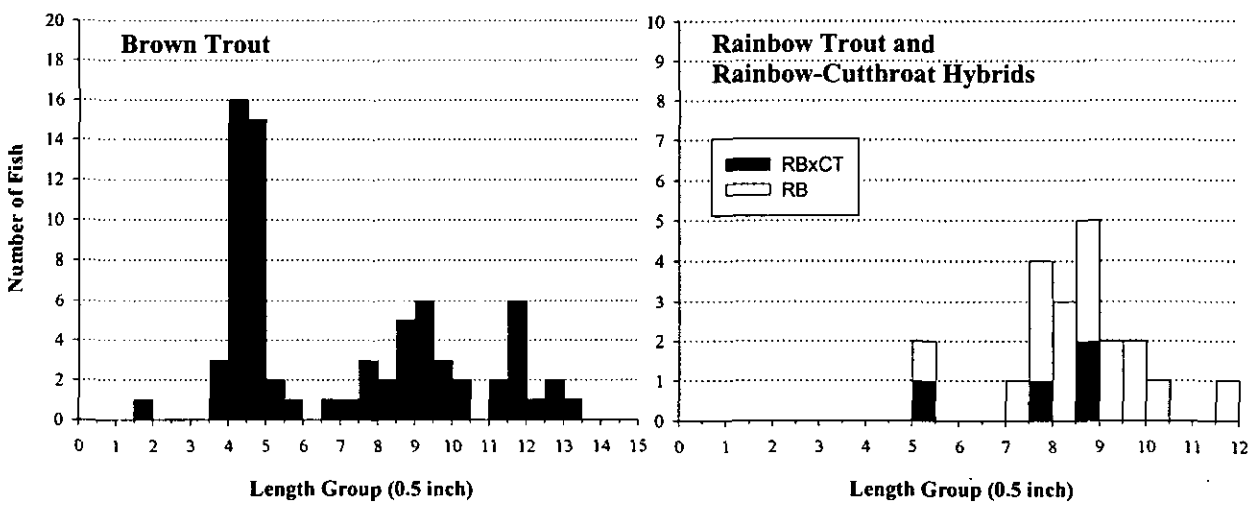

Figure 93. Length frequencies for brown trout (left), rainbow trout (RB) and hybrids between rainbow trout and cutthroat trout (RBxCT) (right) captured in Wolf Creek during 1999.

Comparison to Previous Sampling

At stream mile 4.8 a debris dam creating a 4-foot vertical drop presents a possible barrier to upstream fish movement. A 14 inch-long rainbow trout was captured by hook and line above this debris jam during a 1996 inventory (J. Brammer, Montana FWP, Dillon, files). However, similar to our results, no fish were observed or captured in two electrofishing sample sections above the debris jam during that same inventory. From our observations it appears likely that larger fish can bypass this debris jam, especially if the hydraulics at the debris jam change during higher stream discharge. Although the debris jam should not be considered a definite barrier to fish migration, our results indicate that trout have not successfully colonized the area above the debris jam.

Spring Creek entering from West near $3 Bridge

A short spring creek enters the Madison River from the west just below the $3 Bridge (Figure 1). This spring creek was surveyed as part of a Montana FWP Future Fisheries Improvement project evaluation. In about 1996 the lower portion of the spring creek was moved into a new channel from an existing pond. This allowed fish from the Madison River to access the spring creek. In addition, livestock was fenced out of the lower portion of the spring creek and the channel was enhanced with deep pools, undercut banks, and riparian vegetation was planted.

Habitat

No detailed or reach habitat surveys were conducted. Photo points were established to monitor the habitat improvement project.

Fish Distribution and Abundance

Only brown trout were captured in the two sections of this spring creek. It was obvious that the abundance of young-of-the-year (< 3 inch) brown trout increased dramatically between 1997 and 1998 in both sections (Figure 94). We are presently unsure if this increase was due only to allowing easier access into this spring creek by adult brown trout from the river, or was also enhanced by the additional habitat improvement work in the lower creek. Relative abundance of brown trout 3 inches and longer went down slightly in both sections between 1997 and 1998. We estimated that the re-constructed stream channel section supported an estimated 184 (SE: 74) age 0 (< 4 inch) and 7 (SE: 1) age 1 and older brown trout in 1997 and 592 (SE: 40) age 0 and 9 (SE: not estimatible because all captured on first pass) age 1 and older brown trout in 1998.

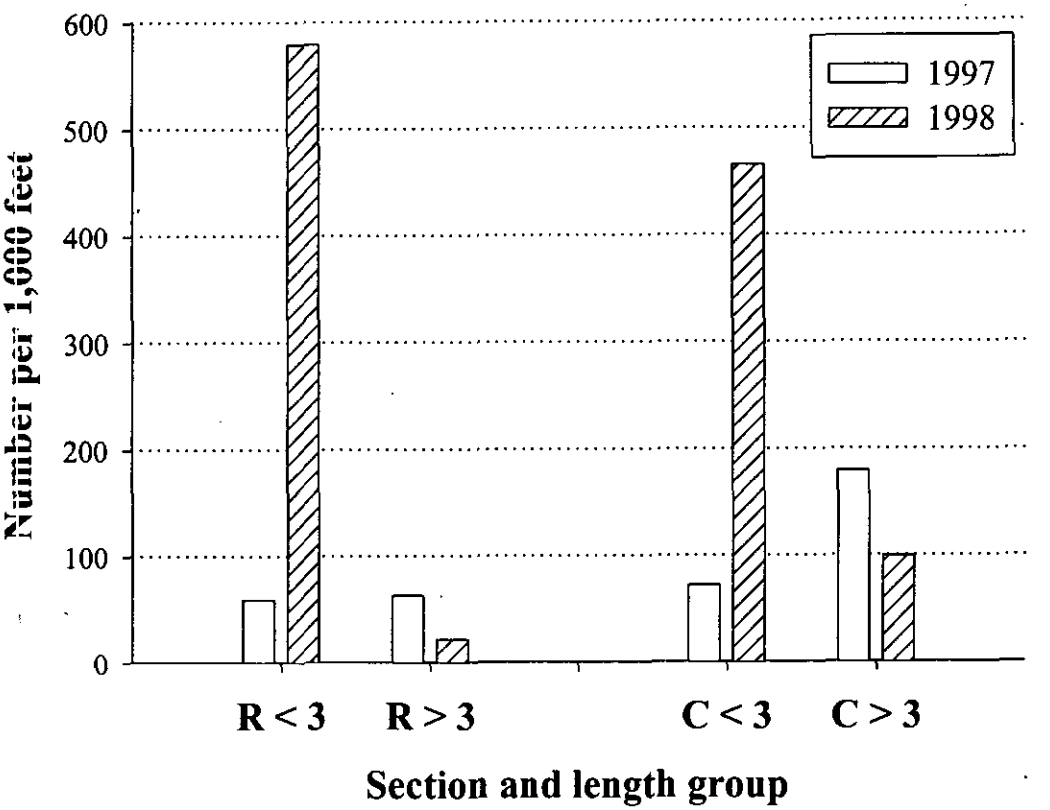

Figure 94. Catch of brown trout less than 3.0 inches (<3) and 3.0 inches and longer (>3) in a single electrofishing pass standardized to number of fish per 1,000 feet of stream length in a lower rehabilitated (R) and an upper control (C) sections of a small spring creek that enters the Madison River from the west just below the $3 Bridge in 1997 and 1998.

Fish Length and Weight

Length frequency histograms illustrate the importance of this spring creek for rearing young brown trout (Figure 95). Most captured brown trout were less than 3.0 inches in length and three age classes appeared to be present with the age 0 age-class dominating the catch. Age 0 fish were less than 4.0 inches, age 1 fish were 4 to 8 inches, and age 2 and older fish were longer than 8 inches.

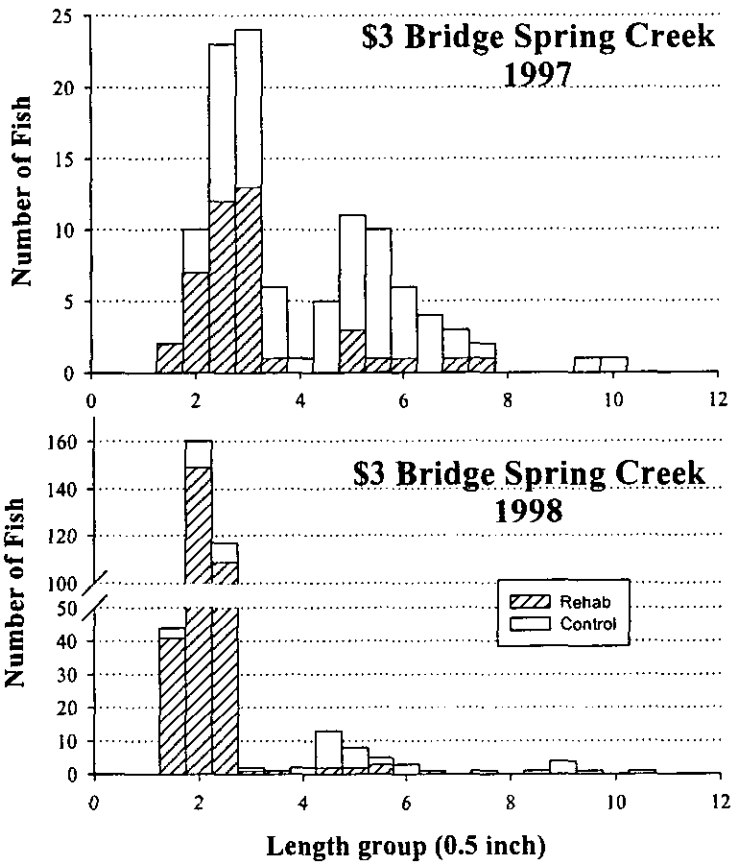

Figure 95. Length frequency histograms for brown trout captured in both a rehabilitated (Rehab) and control (Control) section of a spring creek entering the Madison River from the west below $3 Bridge during 1997 and 1998.

Comparison to Previous Sampling

There are no records of previous sampling for this spring creek from the MRIS database, nor from catalogued reports.

Discussion

Distribution of Westslope Cutthroat Trout

The distribution of westslope cutthroat trout in the Madison River drainage between Hebgen Reservoir and Ennis Lake is concentrated in streams draining the Gravelly Mountains from the West Fork down to Wigwam Creek (Figure 96). Almost all these west-side streams that are perennial, except Ruby Creek, support westslope cutthroat trout. Unfortunately, most of these populations appear to be slightly introgressed with either rainbow or Yellowstone cutthroat trout or both (Table 5). Even those streams with waterfalls that would have prevented upstream invasion by nonnative trout into their headwater habitats, still contained populations that were introgressed. It appears that nonnative trout, particularly Yellowstone cutthroat trout, were widely introduced into headwater habitats of these Gravelly Mountain streams. The only streams that enter from the Madison Range that supported westslope cutthroat trout (>90% purity; Table 5) were Cabin Creek, Papoose Creek, and the South Fork Indian Creek.

The genetic status of many westslope cutthroat trout populations still remains somewhat uncertain due to the possibility that some of these populations may contain a "deviant allele" that is a diagnostic allele characteristic of rainbow trout. This situation likely exists for populations in upper English George, Papoose and Wall creeks, and may exist for a few other populations. The westslope cutthroat trout population in upper Soap Creek has been shown to have a very small infusion of Yellowstone cutthroat trout (< 1%) genetic material in a few individuals. Additional genetic sampling will probably be necessary for some of these populations to clarify their genetic status.

Relative Abundance of Trout Populations

The mean (33.1) and median (24.4) catch of trout per 1,000 feet of stream length in a single electrofishing pass in 232 Madison tributary sample sections where at least 100 feet of stream length was sampled were much lower than mean (81.2) and median (62.4) catches in 702 tributary sample sections from other drainages in the upper Missouri and upper Clark Fork river basins. The frequency of catch rates per 1,000 feet of channel for Madison River tributaries illustrated that catch rates for the majority of sample sections were under 40 fish per 1,000 feet and none of the Madison sections had catch rates higher than 160 fish per 1,000 feet (Figure 97). The same type of relationship existed when catch rates were plotted against average wetted widths of sample sections (Figure 98). It appears that once wetted widths exceed approximately 12 to 15 feet, catch rates level off below 150 fish per 1,000 feet, probably a function of lowered capture efficiency in wider streams. We suspect that the relatively low abundance of trout in Madison tributaries may be related the relatively high elevation of this river basin, inherent geologic instability that translates to somewhat unstable stream channels, and moderate to low productivity of its watersheds. All these factors would lead to a relatively harsh environment for growth and survival.

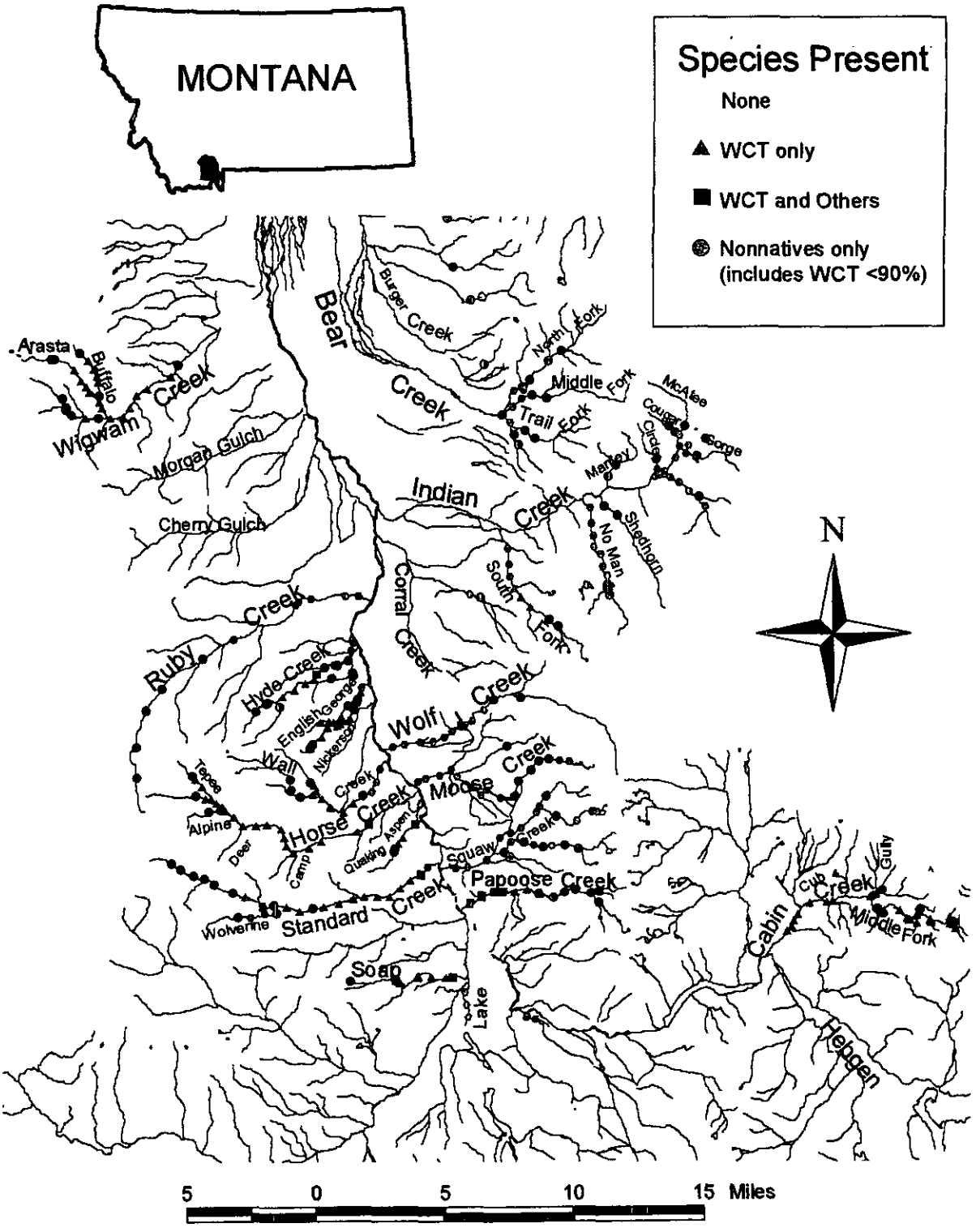

Figure 96. Map of upper Madison River drainage showing where westslope cutthroat trout were found in allopatry (WCT only) or in sympatry with nonnative species (WCT and Others); where only nonnative species were found (Nonnatives; includes known hybridized populations of westslope cutthroat trout that had more than 10% introgression); or where no fish were found (None).

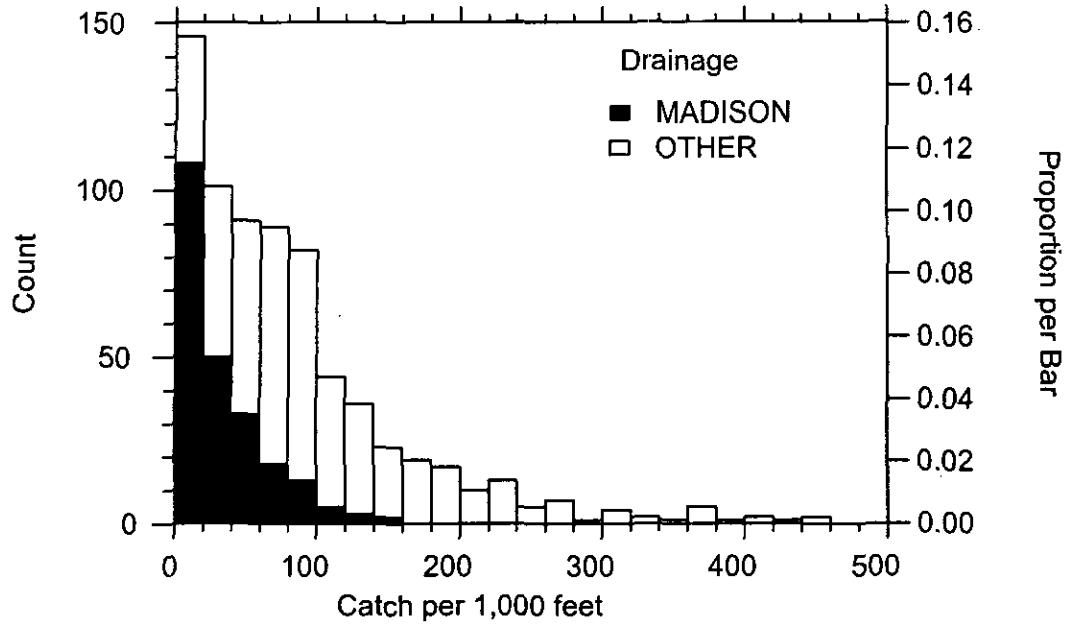

Figure 97. Frequency plot of catch of trout 3 inches and longer per 1,000 feet of stream length during a single electrofishing pass in sample sections where at least 100 feet of stream length was sampled in Madison River tributaries (cross-hatched bars) and in tributaries in other river drainages within the upper Missouri and upper Clark Fork river basins.

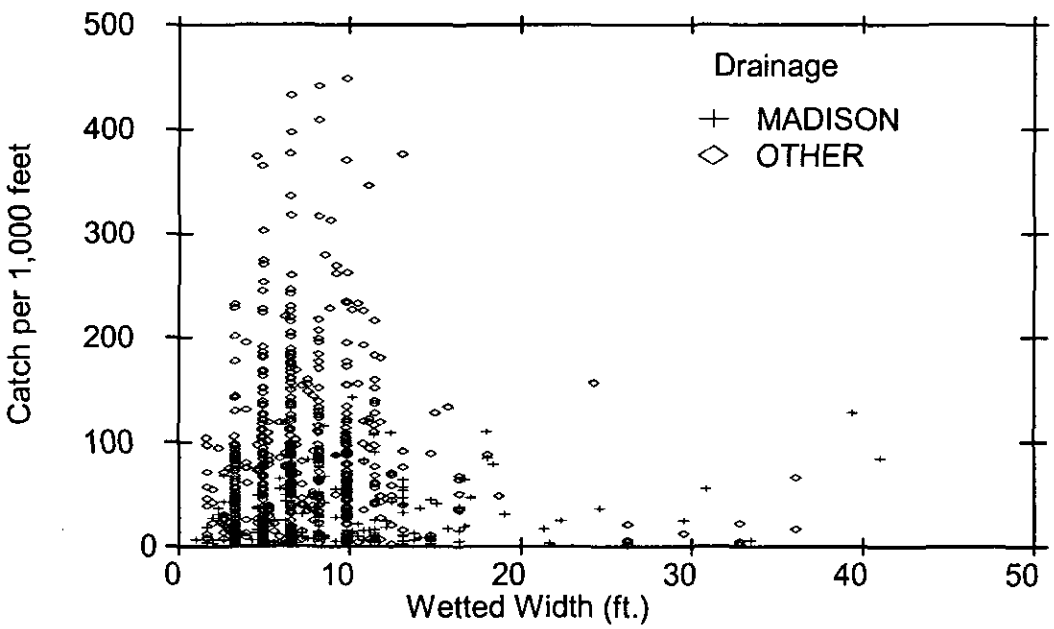

Figure 98. Plot of catches of trout 3 inches and longer per 1,000 feet captured in a single electrofishing pass in sections that were at least 100 feet in length versus wetted width of the sample section for Madison River and other tributaries.

Management Recommendations

Conservation of Westslope Cutthroat Trout

While many tributaries support westslope cutthroat trout, particularly those draining the Gravelly Mountains, few populations remain genetically pure. It is possible that Wall Creek and the upper portions of English George, Papoose, and South Fork Indian creeks support pure populations, however, additional sampling must be done in these areas to confirm their status. The Soap Creek appears to be very slightly introgressed. We recommend managing westslope cutthroat trout populations in the Arasta (Wigwam drainage), Cabin, English George, Horse (above mile 7.5), Hyde, Papoose (above mile 2.5), Soap, South Fork Indian (above mile 2.5) and Wall creek watersheds as conservation populations until a detailed Madison River conservation plan has been completed. We strongly recommend maintaining this conservation designation for these populations in any future conservation plan because these populations are all greater than 95% pure and many of them have been isolated from potentially hybridizing influences for decades. However, until definitive genetic testing confirms the genetic purity of any of these possibly slightly introgressed populations, we do not recommend construction of barriers to further isolate any of these populations.

Due to the limited number of genetically pure populations of westslope cutthroat trout in the Madison drainage, we believe it would be worthwhile to replicate existing pure populations. We recommend that further genetic testing be completed in the English George, upper Papoose, upper South Fork Indian, and Wall creek drainages to confirm the presence of genetically pure populations in these areas. Should any of these populations prove to be genetically pure with at least a 50 fish sample, that population should be replicated, preferably somewhere within the Madison River drainage, as soon as technically feasible to conserve these unique genetic resources. If other populations are found to be genetically pure, we suggest that one or more of these genetically pure populations should also be replicated.

Dispersal of westslope cutthroat trout from headwater portions of tributaries into the lower reaches of tributaries and into the Madison River currently appears to occur at a very slow rate. Westslope cutthroat trout have not yet been found in very high numbers in the Madison River suggesting that the niche opened up in the Madison River after whirling disease reduced densities of rainbow trout has not yet been significantly exploited by westslope cutthroat trout. Initial analyses of the catches of fish identified as cutthroat trout or hybrids between cutthroat and rainbow trout in Madison River sample sections show higher numbers of these fish captured after 1991, the year whirling disease likely began influencing rainbow trout populations in the river (Figure 99). These increases occurred even though Hebgen Reservoir was stocked with Yellowstone cutthroat trout from 1979 to 1987. In addition, this type of life history adaptation will probably take at least two to three generations (10-15 years) to develop enough to be measurable. We recommend caution in assuming that westslope cutthroat trout will not exploit this niche, and suggest continued monitoring for the presence of westslope cutthroat trout during annual fish population sampling within the Madison River. We suggest that westslope cutthroat trout may have a fluvial life history strategy that might allow them to be less vulnerable to whirling disease by spawning and rearing in tributaries (Shepard et al. 1984). It might be

worthwhile to test this theory by making imprint plants of westslope cutthroat trout eggs or fry into a tributary or tributaries that do not presently support any westslope cutthroat trout.

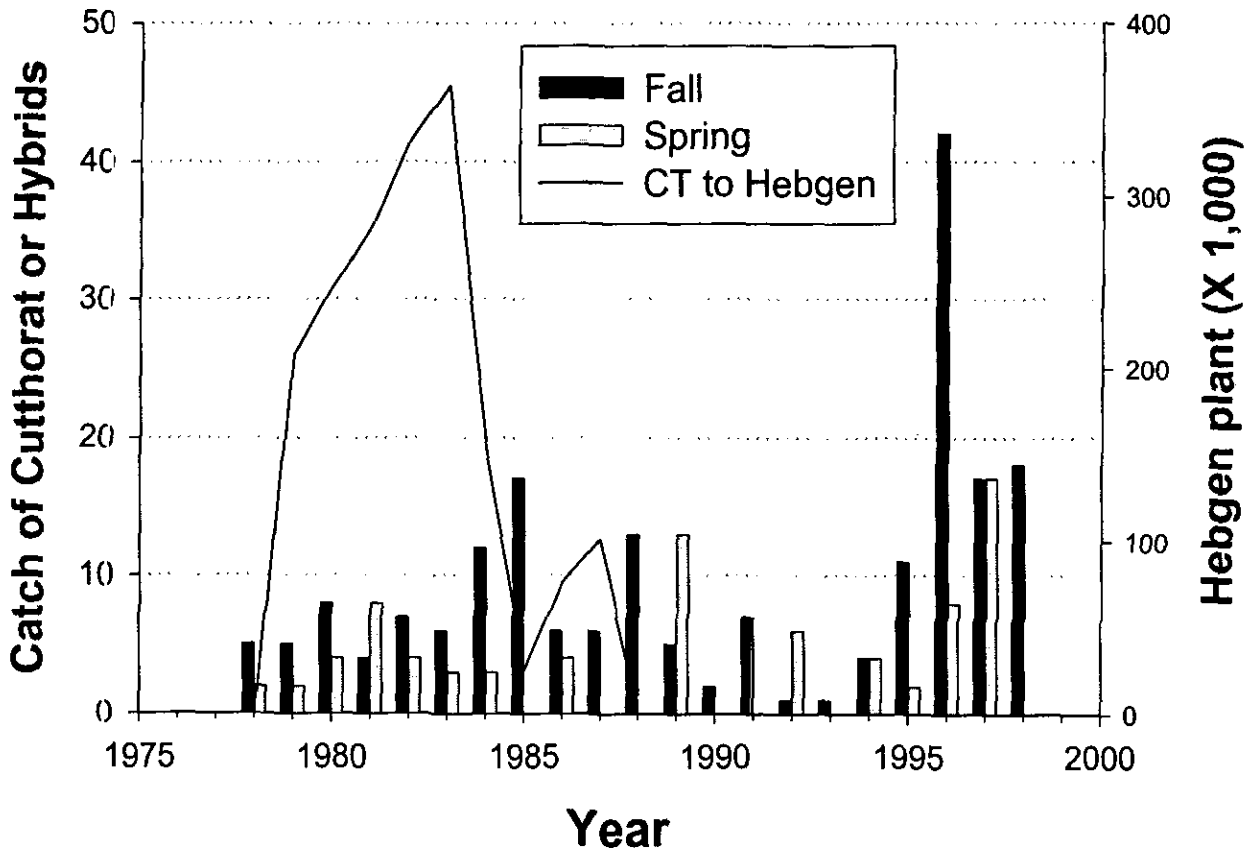

Figure 99. Catch of cutthroat and rainbow-cutthroat trout hybrids in the Pine Butte section of the Madison River from 1978 to 1998 during fall (black bars) and spring (gray bars) along with numbers of cutthroat trout stocked into Hebgen Lake (line).

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